Chapter 2. Existing Conditions

This chapter summarizes the analysis of existing traffic conditions for the study section of the US Route 1 Corridor at Marine Corps Base Quantico (MCB Quantico). The following sections describe existing traffic volumes, analysis methodology, and existing operational conditions. Existing lane configuration and traffic control is shown in **Figure 2-1**. The following are signalized and unsignalized intersections along the study corridor:

Signalized Intersections

A. US Route 1/Joplin Road/Fuller Road
B. Russell Road/I-95 (Northbound) On Ramp
C. Russell Road/I-95 (Northbound) Off Ramp
D. Russell Road/I-95 (Southbound) Ramps
E. US Route 1/Corporate Drive/United Van Lines Driveway
F. US Route 1/Telegraph Road

Unsignalized Intersections

1. Fuller Road/Fuller Heights Road
2. Joplin Road/Inn Street
3. Joplin Road/I-95 (Northbound) Ramps
4. Joplin Road/I-95 (Southbound) Ramps
5. US Route 1/Museum of the Marine Corps Driveway[1]
6. US Route 1 (Northbound)/Russell Road Ramps
7. Russell Road/US Route 1 (Northbound) Ramps
8. Russell Road/US Route 1 (Southbound) Ramps
9. US Route 1 (Southbound)/Russell Road Ramps
10. US Route 1/George Mason Drive (North)
11. US Route 1/George Mason Drive (South)

2.1 Traffic and Transportation

2.1.1 Description of Study Area Roads

US Route 1

US Route 1, known as Jefferson Davis Highway in Virginia, along with Interstate 95 (I-95) is one of two major north/south routes in the eastern United States. US Route 1 is parallel to I-95 and located about

[1] A flashing beacon is located at the US Route 1/Museum of the Marine Corps Driveway. The intersection was analyzed as a stop-controlled intersection.

a half mile east of the interstate in most of the study area. In addition to having an important transportation function in its own right, US Route 1 impacts the greater I-95 corridor by serving short- and moderate-distance trips and by acting as a relief to interstate congestion and incidents.

Within the study area, US Route 1 is mostly a four-lane undivided facility. It is classified as an urban principal arterial in the study area. Its typical section is four 11-foot travel lanes and varying-width gravel shoulders on both sides of the road. Turn lanes exist primarily at signalized intersections, the ramps to Russell Road, and residential developments.

The existing horizontal geometry is generally straight with curves at the south and north ends of the study areas. Some of these curves present radii and superelevation configurations that do not meet current Virginia Department of Transportation (VDOT) standards based on the road classification and design speed of US Route 1. The existing vertical geometry corresponds to a generally rolling terrain with some curves that do not meet VDOT standards based on their slopes. These deficiencies were addressed in the alternative development process described later in the report.

The 2010 annual average daily traffic (AADT) was the following in the study area:

- US Route 1 from Joplin Road to Russell Road: 17,000 vehicles per day (vpd)
- US Route 1 from Russell Road to Woodstock Lane: 22,000 vpd

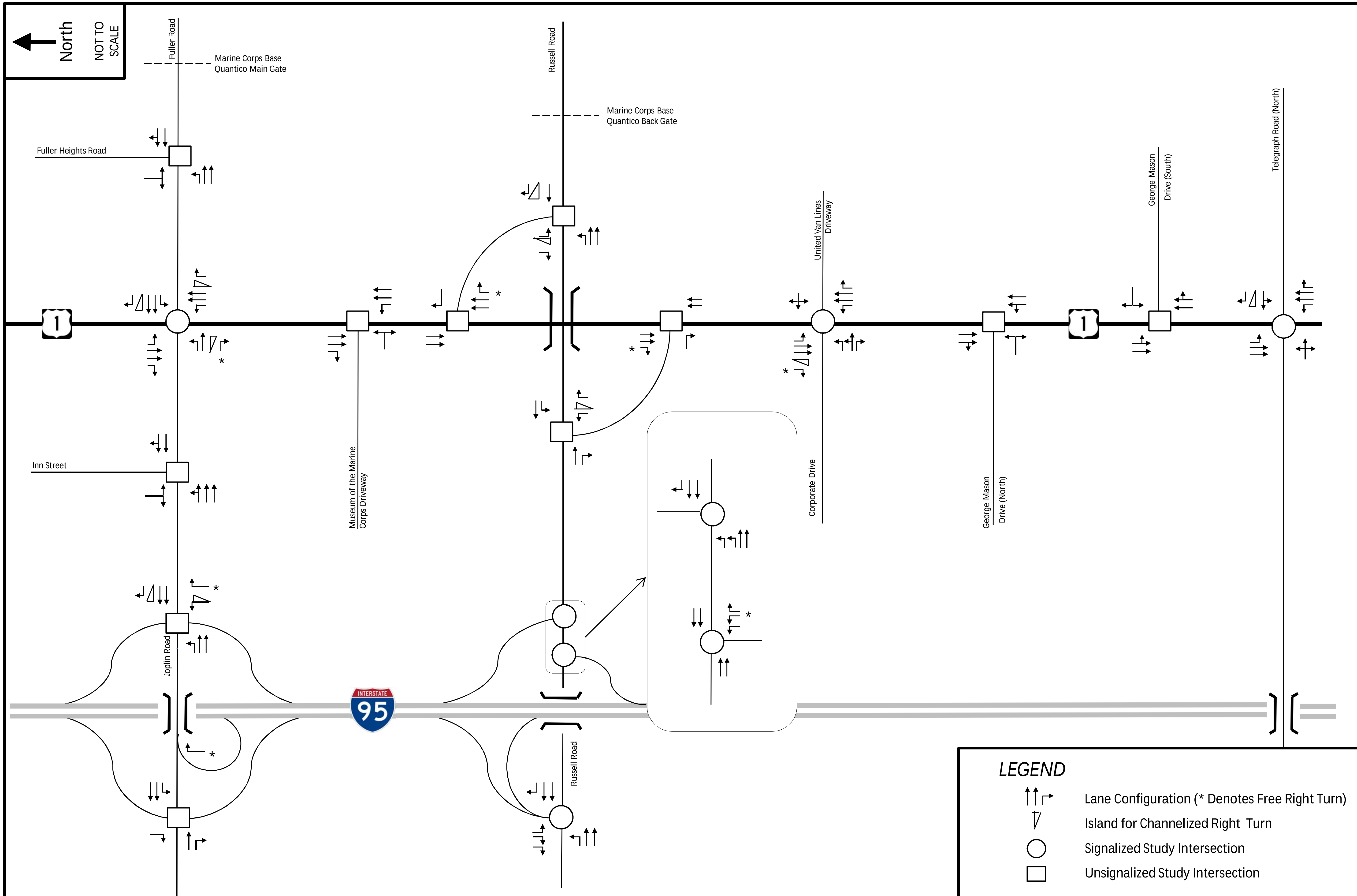
Interstate 95
I-95 is a six-lane interstate facility which runs parallel to the west of US Route 1 through the study area. In 2010, it carried on average approximately 140,000 vpd. Two interchanges are located within the study area: Exit 150 (Triangle/Quantico) at Joplin Road and Exit 148 (Quantico) at Russell Road. Exit 143 (Garrisonville Road) is located about one mile south of the study area. Between Exits 150 and 148, I-95 is classified as a rural interstate. South of Exit 148, I-95 is classified as an urban interstate. Congestion on this section of I-95 is prevalent both during the week and on weekends. This congestion often diverts drivers to US Route 1 as an alternative route.

Joplin Road
Between I-95 and US Route 1, Joplin Road is a four-lane divided urban collector. Access to Joplin Road is limited to one unsignalized intersection with Inn Street. Joplin Road carried approximately 18,000 vpd in 2010. East of US Route 1, Joplin Road becomes Fuller Road.

Fuller Road
Located east of US Route 1, Fuller Road is a two-lane undivided facility. It is the location of the Access Control Point (ACP) known as the "Main Gate" of MCB Quantico. The Main Gate is located approximately 1,000 feet east of the intersection with Fuller Heights Road.

Russell Road
Russell Road is a two-lane undivided facility in the majority of the study area. An ACP for MCB Quantico is located on Russell Road east of the northbound US Route 1 ramps. This ACP is commonly referred to as the Back Gate. Russell Road extends east through MCB Quantico to the Town of Quantico.

West of US Route 1, Russell Road has an interchange with I-95. Russell Road serves as a main route between Mainside and Westside MCB Quantico. Between I-95 and US Route 1, Russell Road carried an average of approximately 13,000 vpd in 2010.



2011 Existing Lane Configuration

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE
2-1

Telegraph Road

Telegraph Road intersects US Route 1 at the southern boundary of the study corridor. It is a two-lane undivided urban collector. The US Route 1/Telegraph Road intersection is signalized. To the east, Telegraph Road approximately parallels US Route 1 serving residential areas south of the study corridor. This portion carried approximately 4,000 vehicles per day (vpd) in 2010. West of US Route 1, Telegraph Road serves MCB Quantico Westside.

2.1.2 Access Management

Within the study area, US Route 1 can be divided into two general sections based on access conditions:

- Section A – Between Joplin Road/Fuller Road and Corporate Drive
- Section B – Between Corporate Drive and Telegraph Road

Figure 2-2 shows the two sections of US Route 1. The characteristics of the two sections are described below.

Section A – Between Joplin Road/Fuller Road and Corporate Drive

North of the US Route 1/Corporate Drive intersection, access to US Route 1 is primarily limited to the Russell Road interchange and the major intersection with Joplin Road/Fuller Road. Right-turn lanes exist at the few other access points within this section. The posted speed limit within this section is 50 miles per hour (MPH). Potential safety and operational concerns noted in site visits in this section of US Route 1 include:

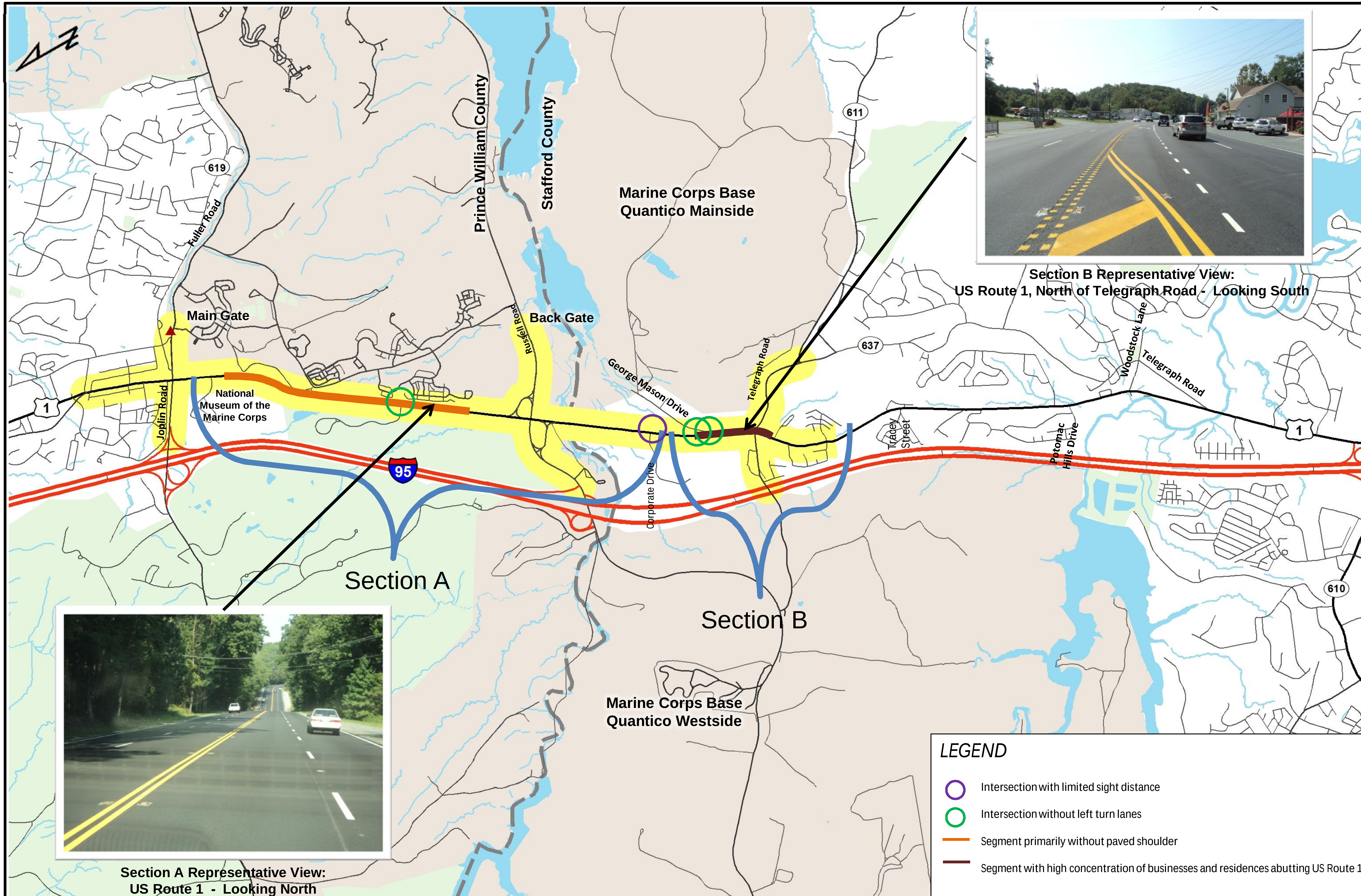
- Lack of paved shoulders
- Lack of median to separate opposing traffic
- Bicyclists riding in travel lane

Section B – Between Corporate Drive and Telegraph Road

South of the US Route 1/Corporate Drive/United Van Lines Driveway intersection, US Route 1 remains a four-lane undivided facility. In this section, US Route 1 is fronted by many businesses and residences, many of which have direct access to US Route 1. Inadequate sight distance appeared to be an issue at the US Route 1/Corporate Drive/United Van Lines Driveway. There is an obstructed view from the westbound approach (United Van Lines Driveway) looking south.

Some of the study intersections do not have left-turn lanes on US Route 1. This can contribute to congestion on US Route 1 as well as crashes, typically rear-end crashes. Left-turn lanes are not provided at the following full-movement study intersections:

- US Route 1/George Mason Drive (North)
- US Route 1/George Mason Drive (South)



2011 Existing US Route 1 Access Map

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

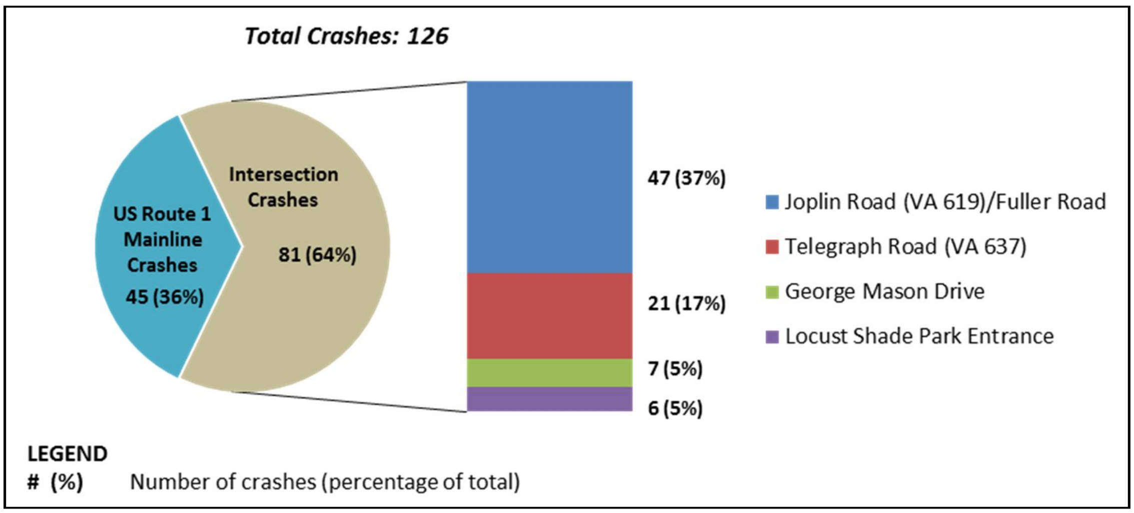
FIGURE
2-2

2.1.3 Crash History

To better understand existing conditions and identify potential safety concerns on the US Route 1 corridor, crash data from 2008 to 2010 was examined. During the three-year period, there were 126 reported crashes that occurred on US Route 1 or at intersections with US Route 1. More than half (64) of the crashes involved injuries and approximately two-thirds (81) of the crashes occurred at or in close proximity to an intersection. There were no crashes involving fatalities reported in this period.

The two intersections that experienced the most frequent crashes were US Route 1/Joplin Road /Fuller Road and US Route 1/Telegraph Road. In addition to these two intersections, three segments of US Route 1 where a high frequency of reported crashes occurred were identified as "High-Frequency Crash Locations". **Figure 2-3** summarizes the crash data. **Figure 2-4** shows a map of the crashes by location and type and identifies the high-frequency crash locations.

Figure 2-3: US Route 1 Historic Crash Data (2008-2010)

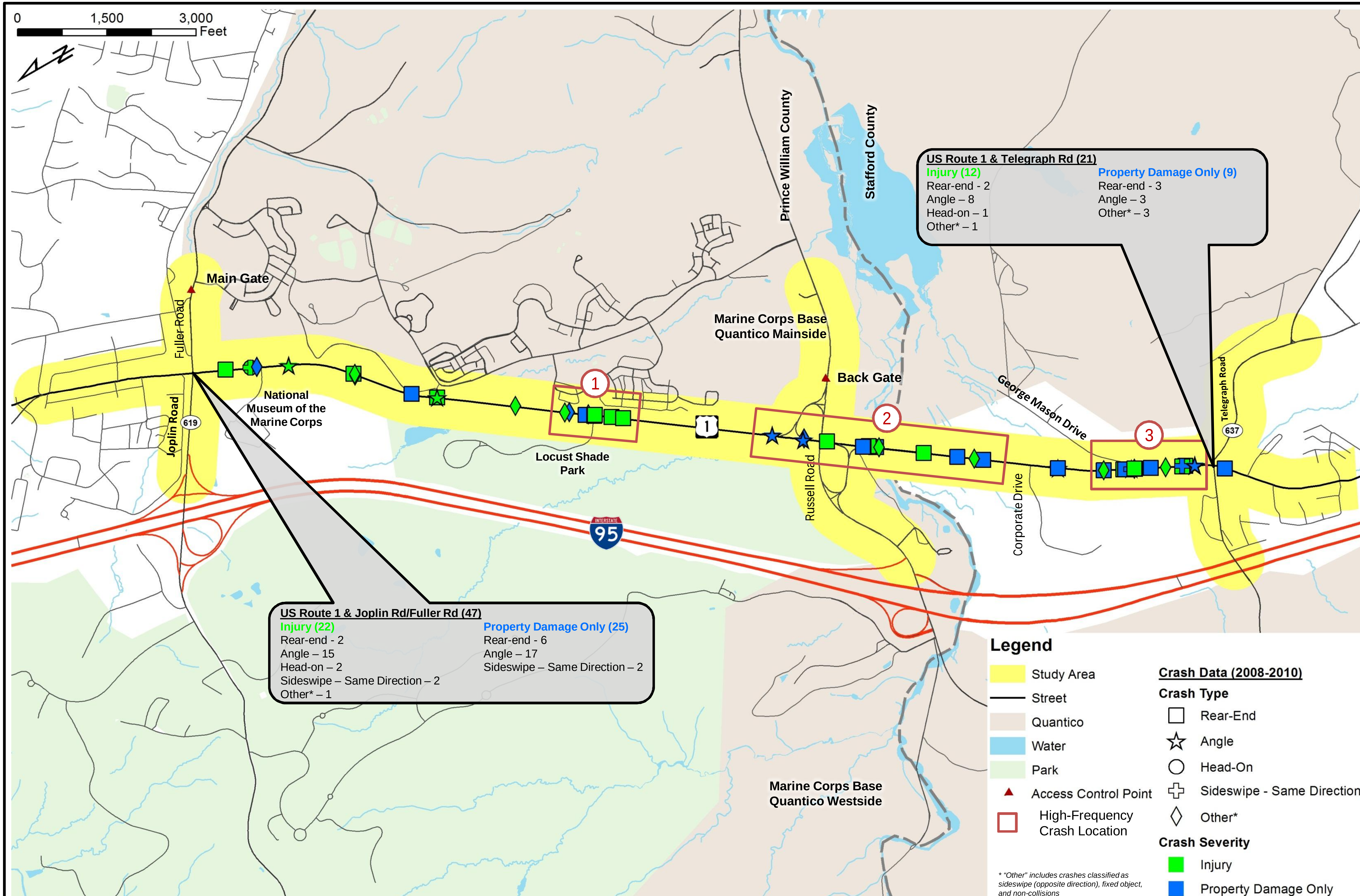


US Route 1/Joplin Road/Fuller Road

Of the 126 total crashes, 47 occurred at or in the vicinity of the intersection of US Route 1/Joplin Road/Fuller Road. The following describes the 47 crashes by crash type:

- 32 angle crashes
- Eight rear-end crashes
- Four sideswipe (same direction) crashes
- Two head-on crashes
- One fixed object (off-road) crash

The high frequency of crashes at this intersection can be partially attributed to the congestion and existing geometry of the intersection. The high percentage of angle crashes at the intersection may be attributed to issues with drivers attempting to turn left on a permitted left-turn phase. Vehicles traveling northbound on US Route 1 and turning right toward the MCB Quantico Main Gate must merge with heavy volumes of eastbound through traffic and southbound left turns. Heavy volumes during the AM and PM peak period make changing lanes at the intersection difficult. This may have contributed to the sideswipe crashes.



Historic US Route 1 Crash Data by Location and Type (2008-2010)

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-4

US Route 1/Telegraph Road

Of the 126 total crashes, 21 occurred at or in the vicinity of the intersection of US Route 1/Telegraph Road. The following describes the 21 crashes by crash type:

- 11 angle crashes
- Five rear-end crashes
- Three sideswipe (opposite direction) crashes
- One head-on crash

The most likely cause for the angle crashes at this intersection is the lack of a protected left-turn phase. Drivers attempting to turn left from US Route 1 oppose heavy volumes in the peak and may attempt to turn without acceptable gaps. Additional potential causes for crashes include access to roadside parking lots and driveways in close proximity to the intersection and inadequate turning radii on the Telegraph Road eastbound approach. The location of the intersection on a curve in US Route 1 and its lack of medians could contribute to the sideswipe crashes.

High-Frequency Crash Location 1

High-Frequency Crash Location 1 is US Route 1 in the vicinity of the entrance to Locust Shade Park. Over the three-year period, 11 crashes (eight rear-end and three fixed object collisions) were reported in this location. The following describes the 21 crashes by crash type:

- Eight rear-end crashes
- Two deer crashes
- One non-collision

The rear-end collisions are likely due to drivers slowing down and/or stopping to make turns into Locust Shade Park. High travel speeds (posted speed limit of 50 MPH) may make avoiding these vehicles difficult for other drivers. At the entrance to the park, US Route 1 has a southbound right-turn lane but no northbound left-turn lane. The two deer crashes occurred in close proximity to each other, just north of the intersection. This could suggest that a lack of appropriate lighting is an issue at this location.

High-Frequency Crash Location 2

High-Frequency Crash Location 2 is US Route 1 in the vicinity of the Russell Road ramps. Over the three-year period, 13 crashes were reported in this location. The following describes the 13 crashes by crash type:

- Eight rear-end crashes
- Two angle crashes
- Two fixed object crashes
- One deer crash

The rear-end collisions can be partly attributed to the congestion that occurs in peak periods associated with MCB Quantico traffic. Queues on the northbound approach can be a cause of crashes due to stop-and-go movement or drivers not being aware they are approaching the end of the queue. Another potential cause for crashes is the acceleration lane of the on ramp to US Route 1 from Russell Road. During site visits, it was noted that drivers have difficulties merging onto US Route 1 in peak volumes due to the short length of the lane and heavy PM peak volumes. Drivers not being able to merge at appropriate speeds could be a cause for rear-end collisions if other drivers are forced to decelerate quickly.

High-Frequency Crash Location 3

High Frequency Crash Location 3 is US Route 1 north of the US Route 1/Telegraph Road intersection, which includes the two offset intersections with George Mason Drive. During the three-year period, 16 crashes were reported in this location. The following describes the crashes by crash type:

- Eight rear-end crashes
- Three angle crashes
- Two sideswipe (same direction) crashes
- Two fixed object collisions
- One sideswipe (opposite direction)

Throughout this section of US Route 1, there are many driveways and parking lots abutting the roadway. The lack of a median, left-turn lanes, and defined access points allow vehicles to enter and exit US Route 1 in multiple locations, increasing the risk of a crash. Rear-end crashes in this section may have been caused by drivers failing to notice vehicles turning from US Route 1 onto George Mason Drive or into one of the many abutting properties. Sideswipe crashes in this location may be attributed to vehicles attempting to exit from these points and quickly merge onto US Route 1.

Safety Conclusions

Analysis of crashes along the US Route 1 corridor has helped identify locations where crashes occurred frequently. Some main factors that likely contributed to crashes at these locations include:

- Intersection geometry and permitted left-turn movements at US Route 1/Joplin Road/Fuller Road
- Lack of a protected left-turn phase at US Route 1/Telegraph Road
- Lack of left turn lanes at the entrance to Locust Shade Park and George Mason Drive (north and south)
- Inadequate acceleration lane length at Russell Road off-ramp to US Route 1 southbound
- Uncontrolled access to parking lots and driveways between George Mason Drive (north) and Telegraph Road

2.1.4 Traffic Volumes

Intersection Turning Movement Counts

Weekday intersection turning movement traffic counts were conducted in September 2011. Turning movement volumes were performed during the weekday (6:00 AM to 8:30 AM and 3:30 PM to 7:00 PM) peak periods. Counts were performed at the following locations:

Signalized Intersections

- US Route 1/Joplin Road/Fuller Road
- US Route 1/Corporate Drive/United Van Lines Driveway
- US Route 1/Telegraph Road

Unsignalized Intersections

- Fuller Road/Fuller Heights Road
- Joplin Road/Inn Street
- Joplin Road/I-95 (Northbound) Ramps
- Joplin Road/I-95 (Southbound) Ramps
- US Route 1/Museum of Marine Corps Driveway
- US Route 1 (Northbound)/Russell Road Ramps

- US Route 1 (Southbound)/Russell Road Ramps
- US Route 1/George Mason Drive (North)
- US Route 1/George Mason Drive (South)

Weekday turning movement counts were obtained from other recent studies at the following locations:

- Russell Road/I-95 (Northbound) On Ramp[2]
- Russell Road/I-95 (Northbound) Off Ramp[2]
- Russell Road/I-95 (Southbound) Ramps[2]

From the traffic counts, weekday peak hour traffic volumes were calculated using the peak 60 minutes of traffic during weekday AM and PM peak periods. The turning movement count summary sheets are included in Appendix C. The overall peak hours for the study area intersections based on the turning movement counts are 6:45 AM to 7:45 AM and 4:15 PM to 5:15 PM. These peak hours were used as the basis for all analysis.

Daily Traffic Counts

Automated traffic recorder (ATR) data from September 13, 2011, to September 14, 2011, was used to collect 24-hour bi-directional average daily traffic volumes at the following locations:

- US Route 1 between Joplin Road/Fuller Road and Russell Road
- US Route 1 between Russell Road and Corporate Drive

Additional average daily traffic count data was obtained from other recent studies and VDOT for the following sections of roadways in the study area:

- Russell Road between I-95 and US Route 1[2]
- Russell Road between Access Control Point (ACP) and US Route 1 Northbound Ramps[2]
- US Route 1 North of Joplin Road/Fuller Road[3]
- Joplin Road between US Route 1 and I-95[3]
- I-95 between Joplin Road and Russell Road[3]
- I-95 between Russell Road and Garrisonville Road[3]
- Telegraph Road East of US Route 1[3]
- Telegraph Road West of US Route 1[3]

Figure 2-5 shows existing peak hour traffic volumes at study intersections and roadway sections. The traffic volumes shown this figure represent raw data and have not been balanced between intersections or adjusted to the same count year. The traffic count data sheets are included in the Appendix. When referring to the raw data sheets, it should be noted that the "(SI)" and "(SO)" indications on the ATR counts summaries refer to the inside lane (SI) and the outside lane (SO).

Existing Traffic Volume Adjustments

In order to account for differences in volumes occurring from counts that were performed on different dates, manual adjustments were made. A summary of the methodology is explained below for each adjustment. **Figure 2-6** shows the traffic volume adjustments and the 2011 adjusted volumes that were used for analysis of the AM peak hour, while **Figure 2-7** shows the PM peak hour volumes.

---

[2] Russell Road Interchange Project, Parsons Transportation Group (Traffic Counts 2010)

[3] 2010 Daily Traffic Volume Estimates –VDOT

September 2011 Turning Movement Counts

US Route 1

Turning movement counts that were performed in September 2011 occurred over two days, Tuesday September 13th and Thursday, September 15th. For the AM peak hour, volumes at the intersections counted on Thursday were adjusted to coincide with the counts from Tuesday due to a substantial difference in overall volume. The counts performed on Tuesday were used as the standard due to the fact that the counted volumes at these intersections coincided most closely with the daily averages obtained from tube counts. Northbound through movement volumes were increased and southbound volumes were decreased at the US Route 1/Telegraph Road intersection in order to coincide with the Tuesday volumes.

Joplin Road

Turning movement counts along Joplin Road were conducted on Wednesday, September 14th. In order to coincide with the US Route 1 counts performed on Tuesday, September 13th, volumes were adjusted to meet the volumes arriving at the US Route 1/Joplin Road/Fuller Road intersection. Proportionate adjustments were made at entrances to the network at the following intersections:

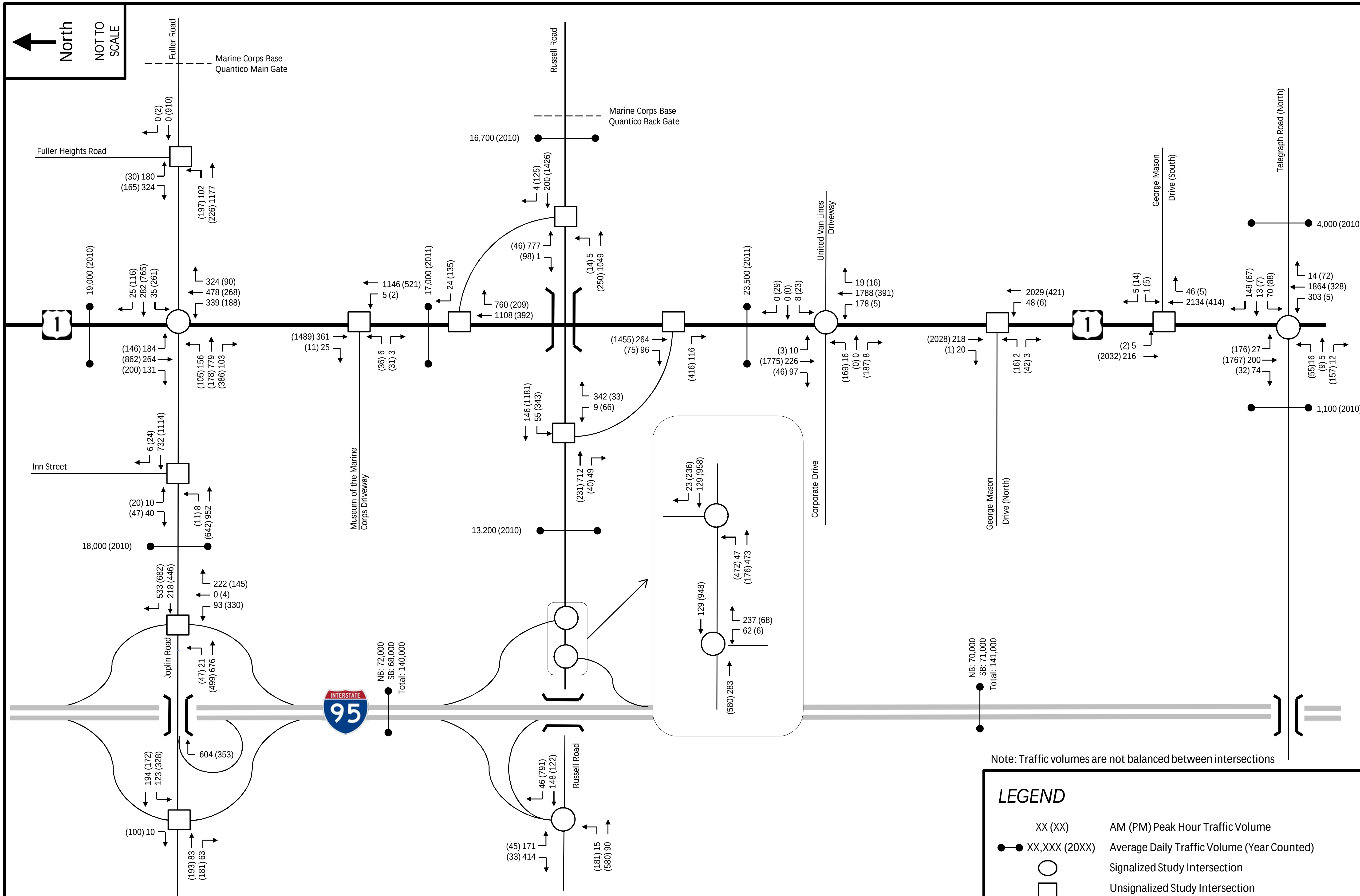
- Joplin Road/I-95 (Northbound) Ramps
- Joplin Road/I-95 (Southbound) Ramps

December 2010 Turning Movement Counts

The turning movement counts that were performed along Russell Road during December, 2010 were adjusted to coincide with the volumes that were counted on US Route 1 in September 2011. Adjustments were made to the volumes arriving at Russell Road from the US Route 1 exit ramps and the volumes turning off Russell Road onto the US Route 1 entrance ramps at each of the following locations:

- Russell Road/US Route 1 (Northbound) Ramps
- Russell Road/US Route 1 (Southbound) Ramps

The large volume of vehicles arriving at the southbound ramp terminus in December 2010 was assumed to be caused by the construction occurring at the Main Gate on Fuller Road at the time of the counts.

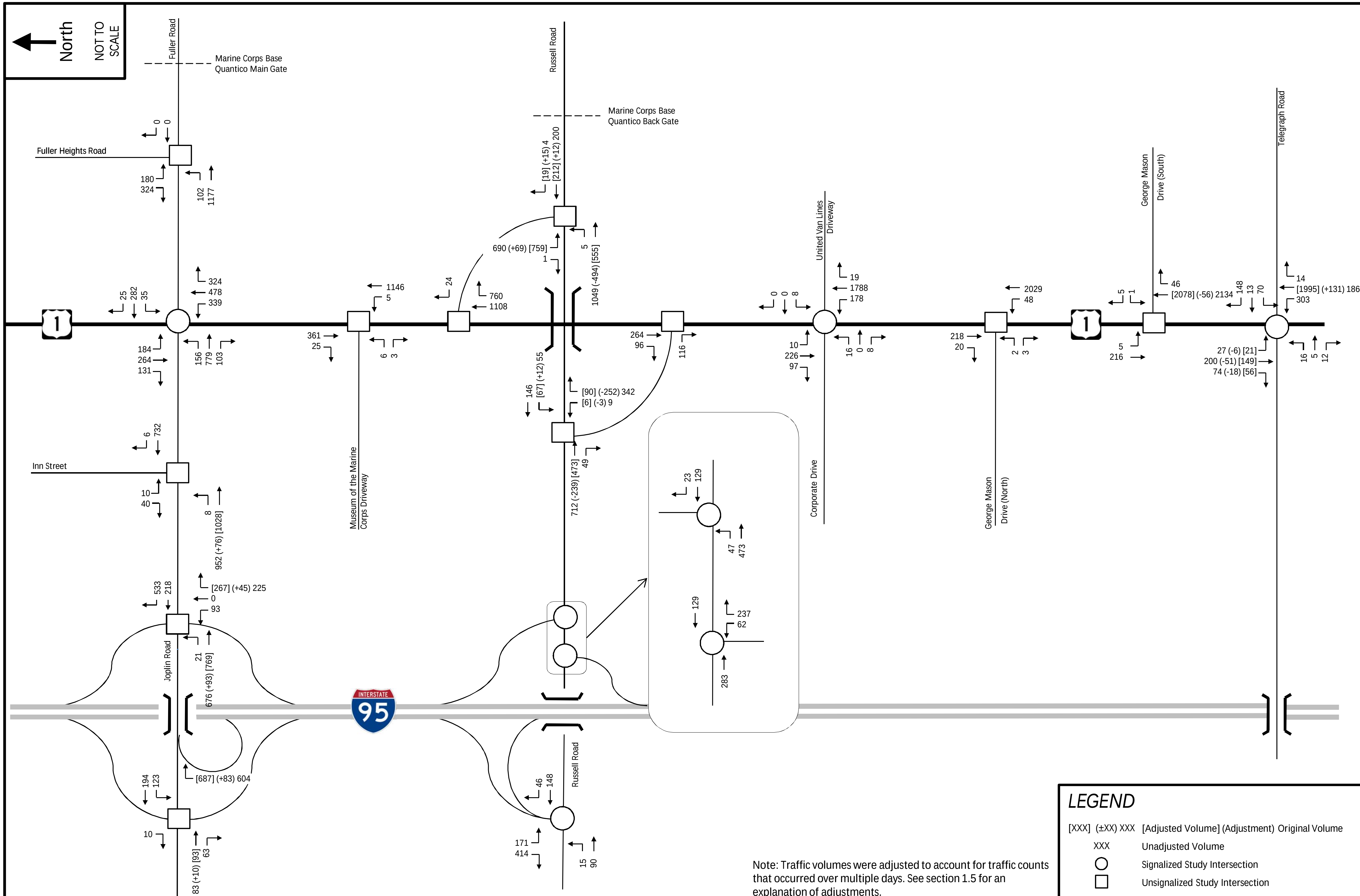


2011 Existing Traffic Volumes

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE
2-5



Note: Traffic volumes were adjusted to account for traffic counts that occurred over multiple days. See section 1.5 for an explanation of adjustments.

LEGEND

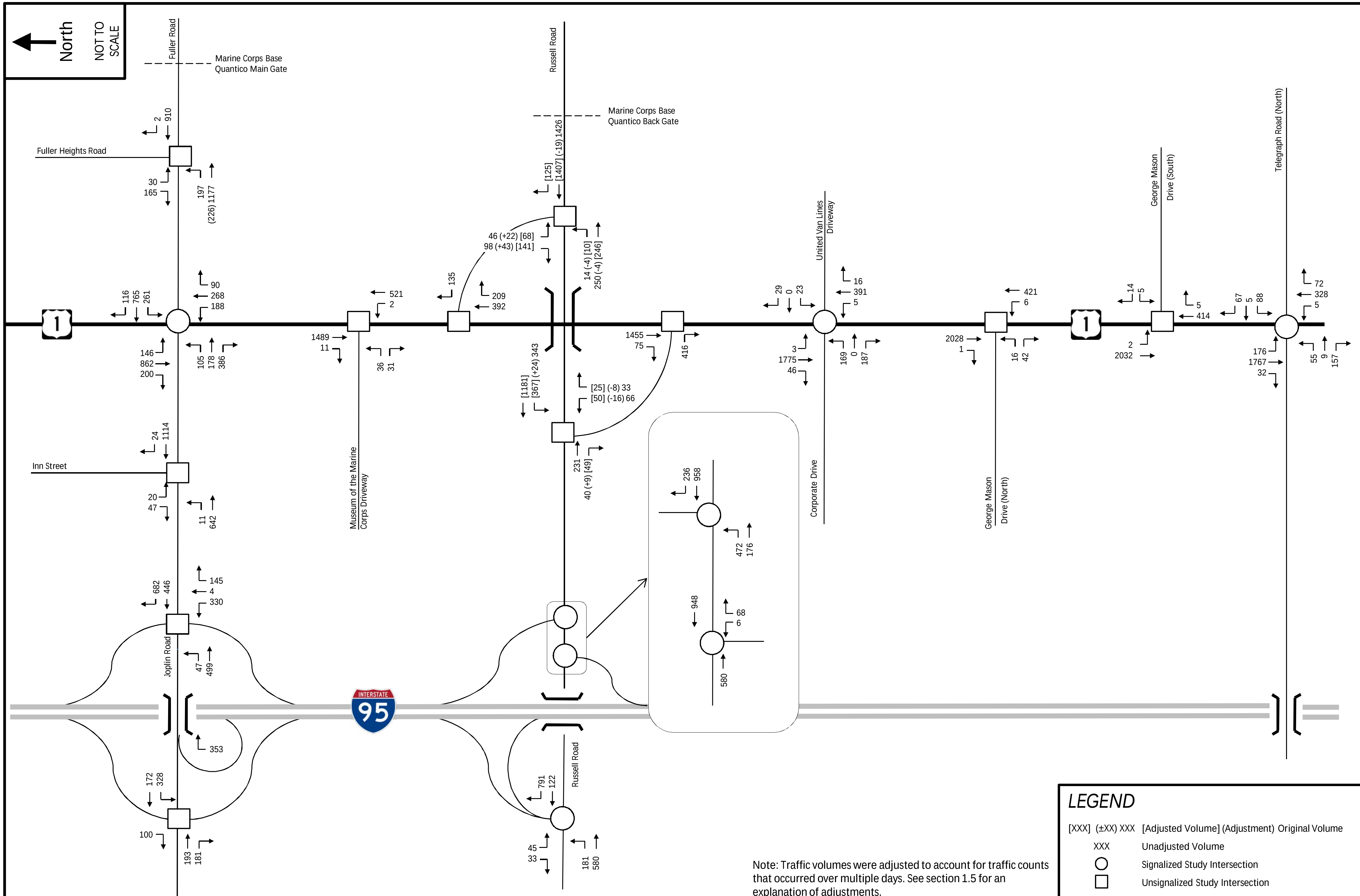
[XXX] (±XX) XXX	[Adjusted Volume] (Adjustment) Original Volume
XXX	Unadjusted Volume
○	Signalized Study Intersection
□	Unsignalized Study Intersection

2011 a.m. Peak Hour Traffic Volumes

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-6



2011 p.m. Peak Hour Traffic Volumes

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-7

2.1.5 Analysis Tool Selection Process

The analysis tool selection process was conducted using the selection criteria in the Federal Highway Administration (FHWA) Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools, July 2004. This procedure identifies the criteria that should be considered in the selection of an appropriate analysis tool and helps identify the circumstances when a particular type of tool should be used. The analysis tools, ranging from high-level sketch planning to detailed microsimulation, are:

- Sketch Planning
    - Purpose: general order-of-magnitude estimates of travel demand and traffic operations
    - Examples: Highway Design and Management, QuickZone, TEAPAC
- Travel Demand Modeling
    - Purpose: forecast future travel demand based on current conditions and future projections of household and employment characteristics
    - Examples: CUBE/TP+/Viper, TransCAD
- Analytical/Deterministic Tools (HCM Methodologies)
    - Purpose: estimate capacity and performance measures to determine the level of service
    - Examples: aaSIDRA, HCS, Synchro, TEAPAC/Signal2000, TRAFFIX
- Traffic Signal Optimization
    - Purpose: develop optimal signal phasing and timing plans for traffic signals
    - Examples: Synchro, PASSER, TRANSYT-7F
- Macroscopic Simulation Models
    - Purpose: model traffic in distinct transportation sub-networks considering a platoon of vehicles rather than tracking individual vehicles
    - Examples: BTS, SATURM, VISTA
- Mesoscopic Simulation Models:
    - Purpose: model traffic by simulating the movement of individual vehicles based on travel transportation network characteristics
    - Examples: TransModeler, CONTRAM, MesoTS
- Microscopic Simulation Models:
    - Purpose: model traffic by simulating the movement of individual vehicles based on dynamic speed/volume relationships
    - Examples: VISSIM, CORSIM, SimTraffic, INTEGRATION, MITSIM

The selection criteria include:

- Analytical context
- Geographic scope
- Facility type
- Travel modes

- Traffic management strategies
- Desired performance measures
- Cost effectiveness of the tool

This evaluation was performed based on the proposed study alternatives of the US Route 1 Corridor at MCB Quantico project. The criteria identified in the methodology are assigned a relevance score from 0 to 5, which are used to tabulate a weighted score for the appropriateness of each type of analysis tool. The automated spreadsheet tool obtained from the FHWA website was used for this assessment.

2.1.5.1 Selection Criteria

Criterion 0: Analytical Context
This criterion has three categories: Planning, Design, and Operations/Construction. Based on the descriptions provided, the most applicable category for this project is "Design", because the project scope includes evaluating roadway features needed to operate at a desired Level of Service (LOS). This category was assigned a full relevancy score of "5."

Criterion 1: Geographic Scope
It was determined that the most applicable description of the study area was "Segment," which is defined as a linear or small grid network. It was assigned a full relevancy score of "5." The Isolated Intersection category was also considered partially applicable and was assigned a lower relevance score of "2."

Criterion 2: Facility Type
The most relevant categories under the Facility Type criterion were determined to be Arterial and Ramp, which make up the majority of the study area. They were assigned a full score of "5." Several other categories were considered somewhat relevant to the project and were assigned a lower relevance score of "2": Isolated Intersection, Roundabout, Freeway, High-Occupancy Vehicle (HOV) Lane, and Auxiliary Lane.

Criterion 3: Travel Modes
The primary focus of this study will be on the effect of single-occupancy vehicles (SOVs), so that category was assigned the highest relevance score of "5." Since the potential improvement options include HOV and transit alternatives, they were assigned a lower score of "2." Other travel modes are not expected to be included in the study.

Criterion 4: Management Strategy and Applications
This study is focused on improvements to arterial intersections and does not include any other specific intelligent transportation systems (ITS) solutions. As a result, the Arterial Intersections category was the only one considered applicable to this project and was assigned a score of "5."

Criterion 5: Traveler Response
In response to capacity improvements on US Route 1, the various alternatives may include additional traffic diversions to or from the study corridor. However, volume estimates of this trip diversion are envisioned to be performed outside the analysis model. As a result, all categories within this criterion were determined to be not relevant to the simulation tool selection process and were assigned a score of "0."

Criterion 6: Performance Measures
Several performance measures were explicitly stated in the project scope, including HCM-compliant LOS, Delay, Travel Time, Average Vehicle Occupancy, and Transit Ridership. These categories were all assigned a full score of "5" for project relevance. Several other categories were also considered partially relevant and potentially useful measures of effectiveness, including: speed (score 3), volume-to-capacity (v/c) ratio (2), queue length (3), number of stops (3), emissions (3), fuel consumption (3), noise (3), and benefit cost (3).

Criterion 7: Tool/Cost Effectiveness
The cost effectiveness of the selected tool is important when screening multiple alternatives. There are currently 12 improvement alternatives that could potentially be modeled, so an analysis tool that is more cost effective may be necessary for the initial screening. The most relevant categories under this criterion are Data Requirements and Post Processing Requirements. These categories were each assigned a value of "5." However, all other categories were deemed somewhat relevant and were given a score of "1."

2.1.5.2 Criteria Weights
Each of the criterion described above were then assigned an individual weighting factor from 0 to 5. Most of the categories were given an equal weight of "5," including Analysis Content, Geographic Scope, Facility Type, Performance Measures, and Tool/Cost Effectiveness. Two of the categories were given a much lower weight of "2" – Travel Mode and Management Strategy/Applications. Explicitly modeling either of these network features is not required by the project scope, but may be indirectly included in proposed alternatives. For example, the simulation model does not need to model multimodal vehicle interactions, but some alternatives may add a transit-only or HOV-only lane. Traveler Response was determined to be not relevant to the project and was assigned a weight of "0."

2.1.5.3 Simulation and Analysis Tool Selection
Based on the scores assigned in each category, the most suitable analysis tool is microsimulation, with the second ranked option being Analytical (HCM). Microsimulation scores the highest based on its ability to model a wider range of facility types and travel modes, and additional performance measures such as transit ridership, number of stops, and emissions/fuel consumption. As expected, HCM methodology scores higher in Cost Effectiveness. **Table 2-1** summarizes the results of the analysis tool.

The relatively close scores for microsimulation and an analytical tool demonstrate the usefulness of both types of modeling on this particular project. It was recommended that a combined approach of VISSIM microsimulation and HCM-compliant capacity analysis using Synchro be applied to this project to take advantage of the strengths and weaknesses of both software packages. Synchro/HCM cannot fully model the impact of transit and HOV operations in the area or the vehicle interaction between the closely spaced I-95 ramp intersections with the signalized intersections along Route 1. On the other hand, the project scope specified HCM-compliant LOS analysis, which cannot be generated through microsimulation. The cost effectiveness of the Synchro/HCM model was efficient for screening the large number of alternatives down to a few alternatives that merit more detailed analysis using VISSIM microsimulation. VISSIM is capable of explicitly modeling all proposed alternatives proposed for the study area, including non-conventional intersections, transit, and HOV. The coding effort was reduced by obtaining the existing model for Prince William County's section of US Route 1 and exporting signal timing parameters from Synchro into the VISSIM model.

Table 2-1: Analysis Tool Selection Summary

Criteria	Criteria Relevance*	Subtotals							Weighted Score						
		Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim
Analysis Context	5	-495	25	50	50	50	50	50	-2475	125	250	250	250	250	250
Geographic Scope	5	-347	-99	35	23	35	30	35	-1733	-495	175	113	175	150	175
Facility Type	5	14	21	26	20	27	26	27	68	107	129	100	136	129	136
Travel Mode	2	23	30	23	23	23	30	30	47	60	47	47	47	60	60
Management Strategy/Applications	2	0	0	50	50	50	50	50	0	0	100	100	100	100	100
Traveler Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Performance Measures	5	15	18	20	19	19	23	24	73	89	100	96	93	113	118
Tool/Cost Effectiveness	5	11	4	12	11	8	7	7	55	18	59	54	38	34	36
								WEIGHTED TOTALS	-3964	-96	859	759	838	835	874

Criteria Relevance (0 = not relevant, 5 = most relevant)

Most Appropriate Tool Categories:
1. **Micro Sim**
2. **Analytical (HCM)**

Tool Categories:
- Sketch Plan = Sketch-planning methodologies and tools
- TDM = Travel demand models
- Analytical (HCM) = Analytical/deterministic tools (HCM-based)
- Traffic Opt = Traffic optimization tools
- Macro Sim = Macroscopic simulation models
- Meso Sim = Mesoscopic simulation models
- Micro Sim = Microscopic simulation models

Please see the 'Tool Definitions' worksheet for more details

2.1.6 Intersection Capacity Analysis

Existing conditions intersection capacity analysis was performed for each of the 17 study intersections, six of which were signalized at the time of this analysis. Using VISSIM and Synchro, two time periods were analyzed – AM peak hour (6:45 AM to 7:45 AM) and the PM peak hour (4:15 PM to 5:15 PM). The 2011 adjusted AM and PM peak hour traffic volumes and existing intersection configurations were used in the analysis. The following sections describe existing conditions capacity analysis findings.

Intersection capacity is defined by the *Highway Capacity Manual* (HCM), *2000 Edition* as the maximum number of vehicles that can pass through a particular intersection within fixed time duration. The operating conditions are described by LOS, which is a measure of the degree of congestion, ranges from LOS A (free flowing) to LOS F (a congested, forced flow condition). LOS D is generally considered to be the minimum acceptable level of service by most agencies for design and evaluation purposes. **Table 2-2** shows level of service and ranges of delay per vehicle for signalized and unsignalized intersections.

Table 2-2: HCM Level of Service Delay Thresholds

Level of Service (LOS)	Delay per Vehicle (seconds per vehicle)	
	Signalized Intersections	Unsignalized Intersections
A	≤ 10	0-10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

Two simulation models were used to calculate intersection capacity – VISSIM and Synchro. Synchro is a deterministic simulation tool that calculates intersection capacity analysis by directly applying the HCM methodology equations. VISSIM is a microsimulation modeling tool that better simulates unconventional intersection conditions such as grade separation, roundabouts, and transit operations. VISSIM was chosen as a tool to use in this corridor for this reason, since there are several existing and proposed unconventional intersections in the study area. VISSIM simulates individual vehicles traveling through the network and measures the delay (seconds/vehicle) of each vehicle passing through an intersection. The HCM-defined levels of service thresholds are applied to the delay values reported by VISSIM in **Table 2-2** for ease of comparison with the Synchro results, but are not calculated by directly applying HCM methodology.

This study modeled existing conditions of the study area in both programs to take advantage of the strengths of each method. Synchro/HCM methodology is straightforward to interpret and is capable of modeling most intersection types. This model was needed to be able to quickly screen a large number of proposed alternatives. It will be used to narrow down the list of proposed alternatives to be carried forward. VISSIM was required to be able to model some of the existing and proposed unconventional intersection geometry. The trade-off for this extra capability is that the effort required to analyze each alternative is much higher, meaning it will only be used to evaluate those improvement alternatives that scored the best after screening in Synchro/HCM.

Although both software packages are used to analyze traffic operations and report vehicle delays and queuing results, the results from each model can sometimes differ because of the inherent differences in how they model traffic and report delay. This is especially true in this network, which includes numerous two-way stop-controlled intersections with minor side streets as well as signalized intersections running in actuated "free-mode" operation. Each of these intersection types are difficult to replicate with the deterministic delay equations in Synchro/HCM, but the models were both calibrated to match field observed conditions as closely as possible.

- **Two-Way Stop Controlled Intersections** – US Route 1 peak hour traffic volumes are relatively high for a two-way stop controlled intersection. It is reasonable to assume that drivers that are turning out of these minor side-streets would need to be more aggressive and accept smaller gaps in traffic to complete their maneuvers. Peak hour field observations conditions confirmed that the default values for driver aggressiveness in Synchro/HCM were overestimated delay and queuing in most cases. In a few locations, the existing traffic volumes exceeded the limits of the HCM equations and produced an error message that results were no longer valid. An initial comparison of the Synchro/HCM results to VISSIM revealed that VISSIM was more closely replicating real-world conditions. As a result, the critical gap and follow up time parameters in Synchro/HCM were decreased to reflect more aggressive driver behavior and produce delay results comparable to VISSIM. In most cases, the critical gap value was decreased by 1.5 seconds and the follow up time value was decreased by 0.5 seconds.
- **Actuated-Uncoordinated Signalized Intersections** – Most of the signalized intersections in the study area are running in actuated-uncoordinated or "free" mode. In Synchro/HCM methodology, the delay equations assume fully random traffic arrivals and estimates the average green time per signal cycle for each movement. The microscopic nature of VISSIM that models individual vehicles traveling through the traffic network is better able to replicate the true random nature of the actuated signal operations and the influence of surrounding intersections on driver behavior. For example, other traffic signals upstream may alter the vehicle arrival patterns at the intersection or a heavy turning movement at an adjacent intersection just downstream might alter the lane utilization through the analyzed intersection. For these reasons, it can be expected that VISSIM will more accurately reflect real-world conditions.

2.1.6.1 Synchro Highway Capacity Manual (HCM) Analysis
Intersection capacity analyses were performed using *Synchro*, Version 7, which uses methodologies in the HCM for signalized and unsignalized intersections. The Synchro networks used in the analysis were provided by VDOT. **Table 2-3** and **Table 2-4** summarize overall level of service and delay for signalized and unsignalized intersections, respectively. **Figure 2-8** shows the overall level of service vehicle delay by lane group. The Synchro HCM reports are provided in the Appendix.

Table 2-3: Summary of Existing 2011 Intersection Capacity Analysis Results – Signalized Intersections (Synchro HCM Report)

Intersection		Level of Service	Delay, sec/veh
		AM (PM)	AM (PM)
1	US Route 1/Joplin Road/Fuller Road	E (D)	70.8 (45.1)
2	Russell Road/I-95 (Northbound) On Ramp	A (B)	2.5 (15.7)
3	Russell Road/I-95 (Northbound) Off Ramp	A (A)	4.6 (0.9)
4	Russell Road/I-95 (Southbound) Ramps	C (B)	23.9 (19.3)
5	US Route 1/Corporate Drive/United Van Lines Driveway	B (D)	15.1 (38.9)
6	US Route 1/Telegraph Road	B (C)	18.4 (28.1)

Signalized Intersections

The Synchro analysis shows that only one of the six signalized intersections operates at an overall level of service worse than D under existing conditions. The intersection of US Route 1/Joplin Road/Fuller Road operates at LOS E during the AM peak hour with a delay of 71 seconds. The eastbound movements appear to be driving the poor level of service as they experience more than 100 seconds of delay during the AM peak hour. The following intersection approaches operate at a LOS worse than D under existing conditions:

1. US Route 1/Joplin Road/Fuller Road

- Northbound US Route 1 approach – AM peak hour
- Eastbound Joplin Road approach – AM peak hour
- Westbound Fuller Road approach – PM peak hour

5. US Route 1/Corporate Drive/United Van Lines Driveway

- Westbound driveway approach – PM peak hour

6. US Route 1/Telegraph Road (north)

- Eastbound Telegraph Road approach – PM peak hour

Table 2-4: Existing 2011Intersection Capacity Analysis Results – Unsignalized Intersections (Synchro HCM Report)

Intersection		Worst Approach	Approach Delay LOS	Approach Delay, sec/veh	Overall LOS	Overall Delay
		AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
7	Fuller Road/Fuller Heights Road	SB	C* (C*)	19.7* (20.3*)	A* (A*)	5.8* (4.4*)
8	Joplin Road/Inn Street	SB	B (B)	10.5 (11.9)	A (A)	0.4 (0.6)
9	Joplin Road/I-95 (Northbound) Ramps	Ramp	C (C)	20.7 (17.4)	A (A)	2.0 (1.4)
10	Joplin Road/I-95 (Southbound) Ramps	Ramp	B (B)	13.8 (11.0)	A (A)	8.8 (3.8)
11	US Route 1/Museum of the Marine Corps Driveway	EB	B (D)	12.4 (26.3)	A (A)	0.1 (1.4)
12	US Route 1 (Northbound)/ Russell Road Ramps	Ramp	B (A)	10.8 (9.2)	A (A)	0.3 (0.6)
13	Russell Road/US Route 1 (Northbound) Ramps	Ramp	E** (E)	36.9** (37.2)	D** (A)	29.2** (5.9)
14	Russell Road/US Route 1 (Southbound) Ramps	Ramp	B (C)	11.5 (17.9)	A (A)	2.2 (6.9)
15	US Route 1 (Southbound)/ Russell Road Ramps	Ramp	A (D)	8.9 (32.9)	A (A)	3.5 (5.8)
16	US Route 1/George Mason Drive (North Driveway)	EB	B (E)	13.4 (38.6)	A (A)	0.4 (1.2)
17	US Route 1/George Mason Drive	WB	E (C)	48.7 (20.0)	A (A)	0.3 (0.2)

*Delay on the southbound approach was observed in the field due to be much higher due to queuing from the US Route 1/Joplin Road/Fuller Road intersection. Synchro analysis does not take this into account when calculating delay.

**A military officer controls the southbound and westbound movements during the AM peak hour. Conditions were modeled as a signalized intersection to reflect this condition.

Unsignalized Intersections

All of the unsignalized study intersections operate at overall LOS D or better during the AM and PM peak hours under existing conditions. The following intersection approaches operate at a level of service worse than D under existing conditions:

12. Russell Road/US Route 1 Northbound ramps

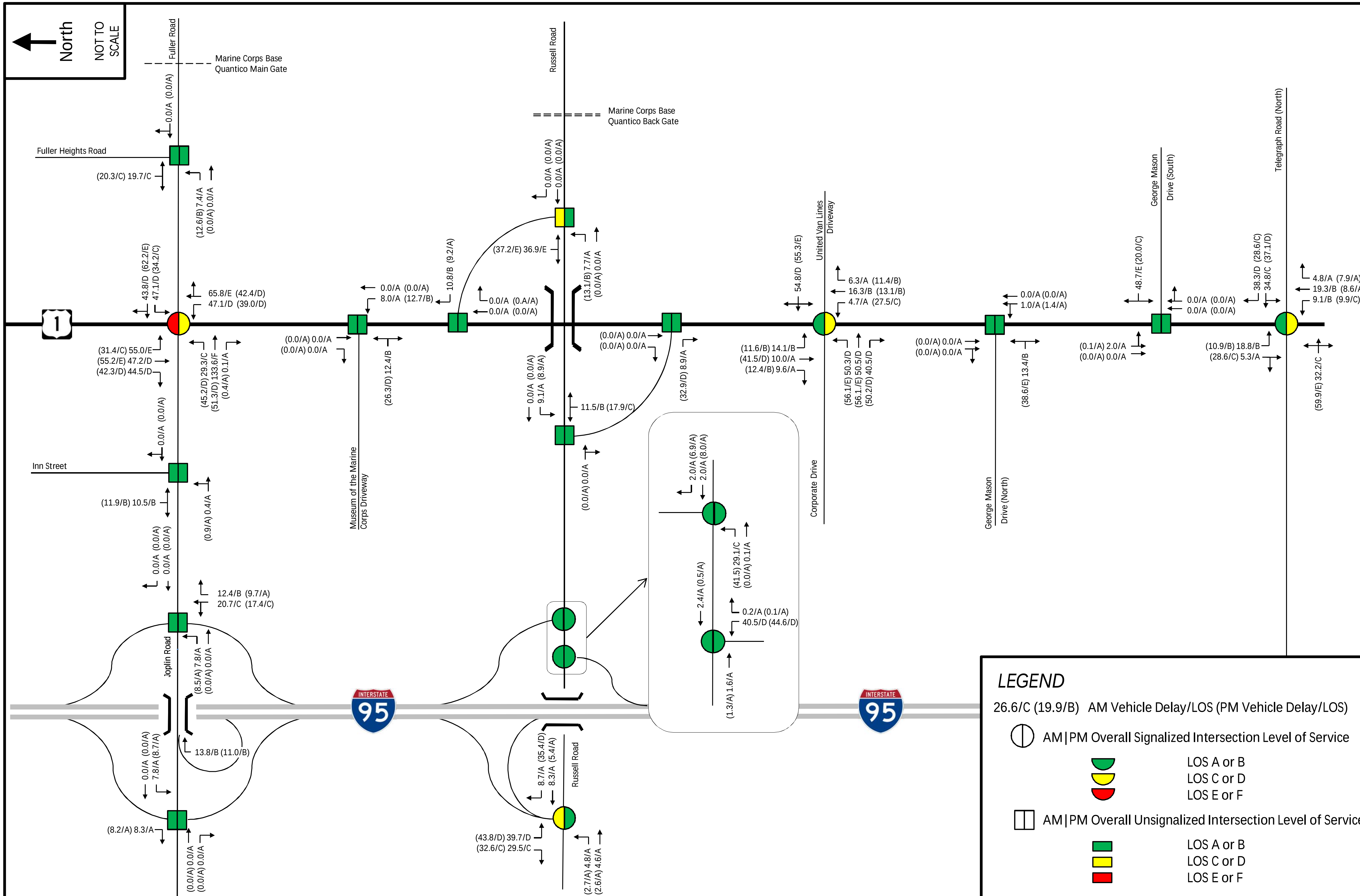
- Southbound ramp approach – AM and PM peak hours

16. US Route 1/George Mason Drive (north)

- Eastbound George Mason Drive approach – PM peak hour

17. US Route 1/George Mason Drive (south)

- Westbound George Mason Drive approach – PM peak hour



2011 Existing HCM LOS By Lane Group

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-8

2.1.6.2 VISSIM Microsimulation Analysis

In addition to analyses prepared using Synchro, microsimulation modeling of the existing conditions was performed using VISSIM software (Version 5.3). The purpose of developing an existing conditions model was to calibrate the model to traffic patterns observed during field visits to the corridor and then use the model as a basis for comparison for subsequent scenarios. To determine intersection capacity, VISSIM measures the delay (seconds/vehicle) of each vehicle passing through the intersection. The results for five separate iterations of the VISSIM model for both the AM and PM peak hours were averaged to account for randomness in the model. The results for delay were classified according to the same HCM-defined thresholds (see **Table 2-2**) for the purpose of comparison. Although similar in magnitude to the Synchro analysis, the delay results from VISSIM are not calculated by HCM methodology. **Table 2-5** and **Table 2-6** summarize the VISSIM results of the overall intersection capacity analysis by signalized and unsignalized intersections, respectively. **Figure 2-9** shows vehicle delay by movement as measured by VISSIM. The figure also shows LOS corresponding to VISSIM reported delays. The VISSIM delay results by movement are provided in the Appendix.

Table 2-5: Summary Existing 2011 Intersection Capacity Analysis Results – Signalized Intersections (VISSIM)

Signalized Intersection		Overall LOS	Delay, sec/veh
		AM (PM)	AM (PM)
1	US Route 1/Joplin Road/Fuller Road	C (C)	34.0 (33.3)
2	Russell Road/I-95 (Northbound) On Ramp	A (B)	3.1 (13.7)
3	Russell Road/I-95 (Northbound) Off Ramp	A (A)	9.7 (1.3)
4	Russell Road/I-95 (Southbound) Ramps	B (A)	17.1 (8.8)
5	US Route 1/Corporate Drive/United Van Lines Driveway	A (B)	4.9 (18.9)
6	US Route 1/Telegraph Road	B (B)	11.0 (16.1)

Signalized Intersections

The results of the capacity analysis show that all of six signalized intersections operate with delays equivalent to an overall LOS C or better under existing conditions during the AM and PM peak hours.

Unsignalized Intersections

The VISSIM microsimulation results show that all of the study unsignalized intersections along US Route 1 currently operate at overall LOS A under existing conditions during the AM and PM peak hours.

The intersection of Fuller Road and Fuller Heights Road, excluding the through movements along Fuller Road, operates with delays that correspond to LOS F in the AM and PM peak hours. In order to accurately measure the delay at the intersection of US Route 1 and Joplin Road/Fuller Road, the eastbound and westbound through movements were not measured in the VISSIM analysis at this intersection. The southbound approach at the intersection of Fuller Road and Fuller Heights Road operates with large delays that correspond to LOS F.

Along Russell Road, the intersection with the US Route 1 northbound ramps is the only intersection to operate with an approach of LOS E or worse under existing conditions. The southbound approach from the US Route 1 northbound ramp had a delay of 42 seconds in the PM peak hour.

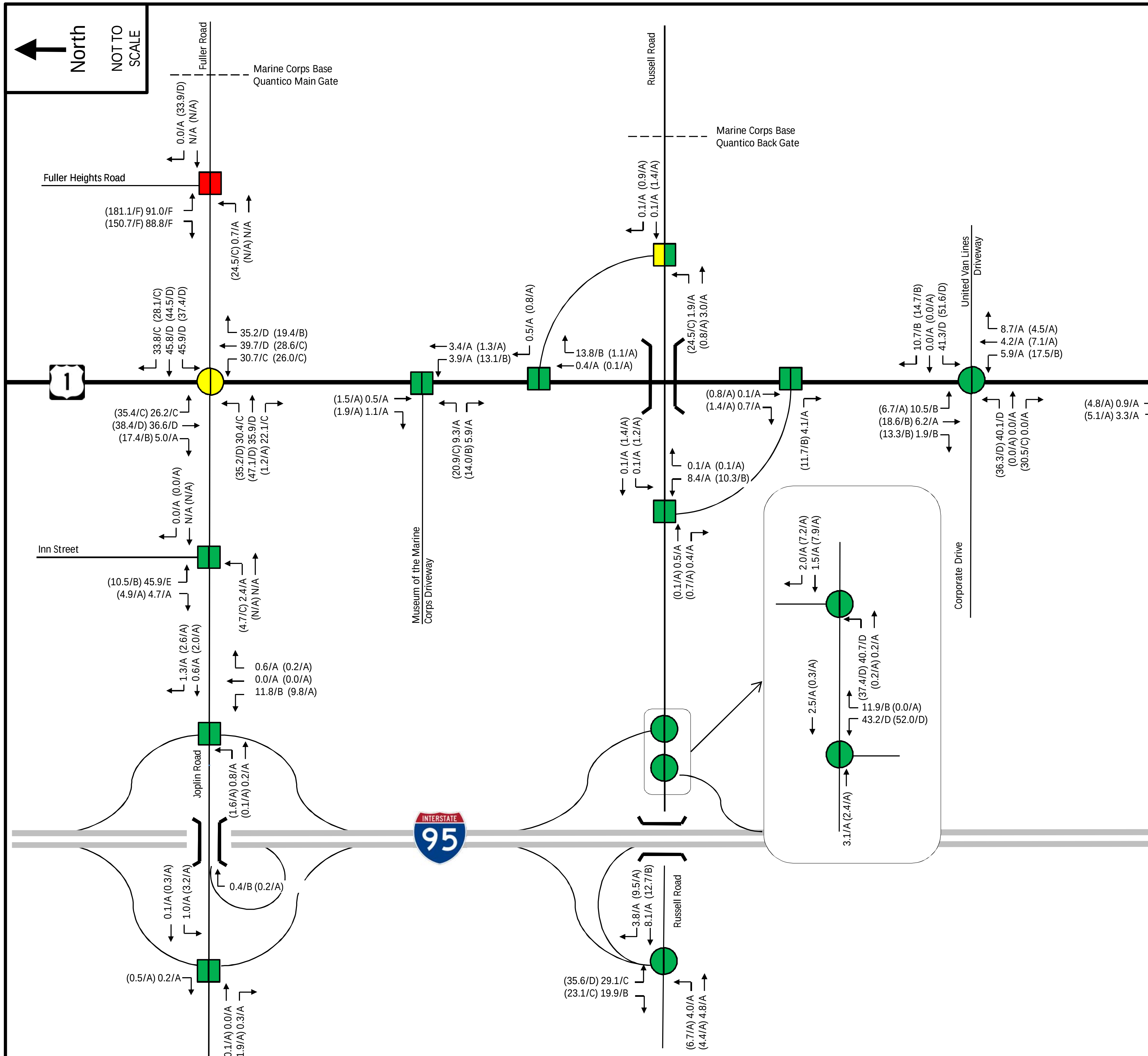
Table 2-6: Summary of Existing 2011 Intersection Capacity Analysis Results – Unsignalized Intersections (VISSIM)

Intersection		Worst Approach	Approach Delay LOS*	Approach Delay, sec/veh	Overall LOS*	Overall Delay
		AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
7	Fuller Road/Fuller Heights Road	SB	F (F)	89.6 (155.0)	F** (F**)	75.4** (88.2**)
8	Joplin Road/Inn Street	SB	B (A)	13.7 (6.6)	B** (A**)	10.6** (4.8**)
9	Joplin Road/I-95 (Northbound) Ramps	Ramp	A (A)	3.9 (2.9)	A (A)	1.3 (1.8)
10	Joplin Road/I-95 (Southbound) Ramps	Ramp (WB)	A (A)	0.4 (2.2)	A (A)	0.4 (1.3)
11	US Route 1/Museum of the Marine Corps Driveway	EB	A (C)	8.2 (17.4)	A (A)	2.7 (2.0)
12	US Route 1 (Northbound)/Russell Road Ramps	NB (Ramp)	A (A)	5.8 (0.8)	A (A)	5.7 (0.5)
13	Russell Road/US Route 1 (Northbound) Ramps	Ramp	D*** (E)	33.5*** (42.0)	C*** (A)	17.8*** (2.9)
14	Russell Road/US Route 1 (Southbound) Ramps	Ramp	A (A)	8.4 (6.6)	A (A)	0.4 (1.4)
15	US Route 1 (Southbound)/Russell Road Ramps	Ramp	A (B)	4.1 (11.7)	A (A)	3.3 (5.0)
16	US Route 1/George Mason Drive (North Driveway)	EB	A (C)	9.0 (18.9)	A (A)	0.3 (4.3)
17	US Route 1/George Mason Drive	WB	C (B)	21.5 (13.3)	A (A)	1.6 (0.5)

*The results for delay were classified according to the same HCM defined thresholds (**Table 2-2**) for the purpose of comparison. Although similar in magnitude, the delay results from VISSIM are not calculated by HCM methodology

** Results reflect only the southbound approaches and eastbound and westbound turning movements. Eastbound and westbound movements were excluded do to the proximity of the intersection of US Route 1 and Joplin Road/Fuller Road.

***A military officer controls the southbound and westbound movements during the AM peak hour. Conditions were modeled as a signalized intersection to reflect this condition.



Note: All LOS results displayed were obtained through classifying delay measured in VISSIM using *Highway Capacity Manual (HCM), 2000 Edition* thresholds

LEGEND

26.6/C (19.9/B) AM Vehicle Delay/LOS (PM Vehicle Delay/LOS)

AM | PM Overall Signalized Intersection Level of Service

- LOS A or B
- LOS C or D
- LOS E or F

AM | PM Overall Unsignalized Intersection Level of Service

- LOS A or B
- LOS C or D
- LOS E or F

2011 a.m. and p.m. Peak Hour VISSIM Delay and HCM Level of Service Results By Movement

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-9

2.1.7 Queue Analysis

Synchro Queue Analysis

Queue length reports were generated by *Synchro 7 for* each of the study intersections based on existing lane designations, traffic volumes, and truck percentages. The queue length reports show 50th and 95th percentile queues for signalized intersections and the 95th percentile queues for unsignalized intersections. The 95th percentile queue represents the maximum vehicle queue length that would occur with 95th percentile traffic volumes. The queue reports are provided in the Appendix.

Synchro analysis shows that the queue length exceeds the storage or lane group capacity at the following signalized intersections:

- US Route 1/Joplin Road/Fuller Road
  - Eastbound through:
    - AM 50th and 95th percentile
    - PM 95th percentile
  - Northbound left, AM and PM 95th percentile
  - Northbound through, AM 95th percentile
- Russell Road/I-95 (Northbound) On Ramp
  - Eastbound Left, PM 95th percentile
- US Route 1/Corporate Drive
  - Northbound through, AM 95th percentile
  - Southbound through, PM 95th percentile
- US Route 1/Telegraph Road
  - Northbound through, AM 95th percentile
  - Southbound through, PM 95th percentile

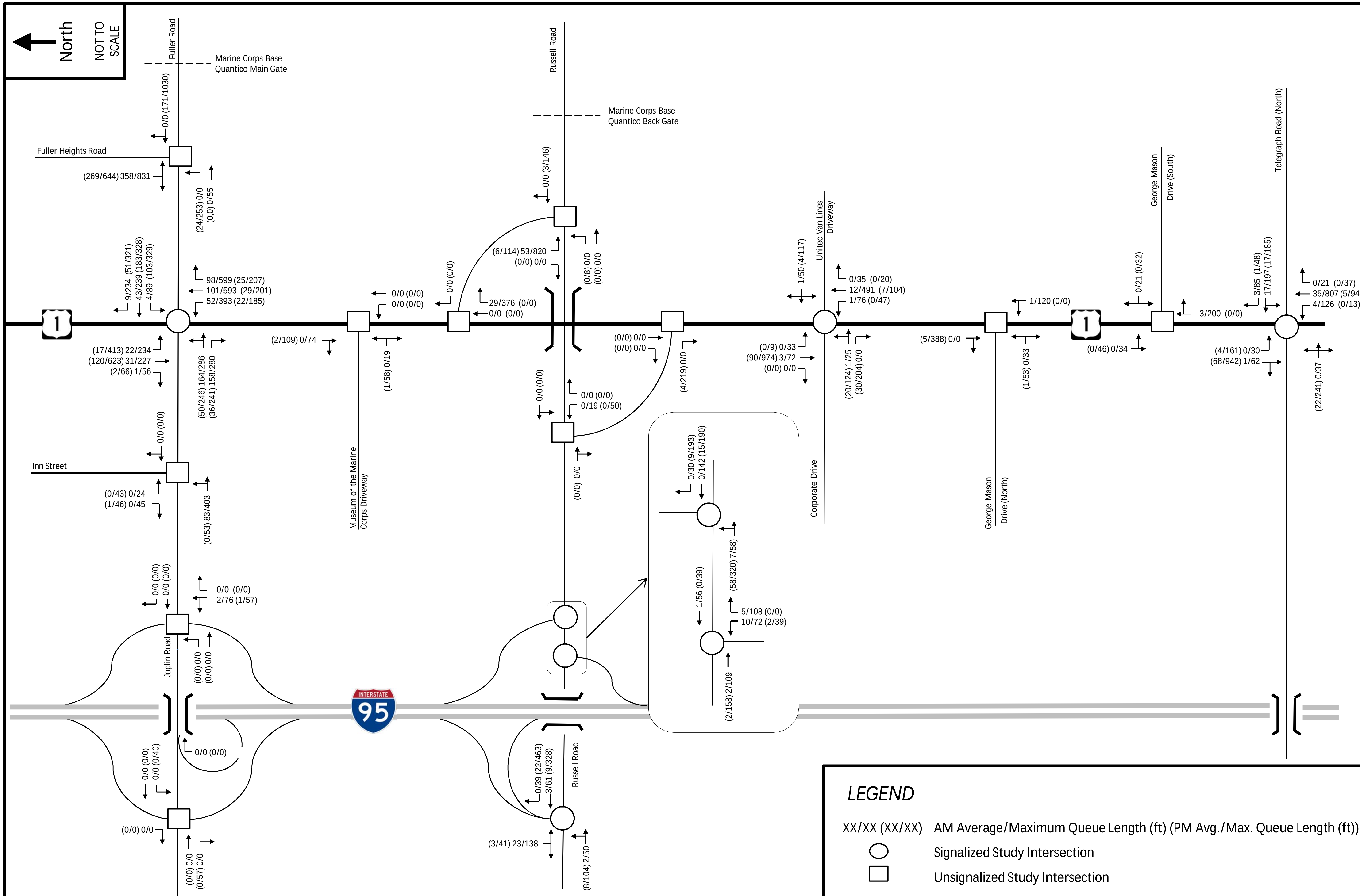
2.1.8 VISSIM Microsimulation Analysis

In addition to the Synchro analysis, queue lengths were measured in the VISSIM microsimulation. **Figure 2-10** shows the average queue length and the maximum queue length recorded during the hour-long simulation for each lane group. These results are also contained in Appendix F.

Approaches with sizable queues include the following:

- US Route 1/Joplin Road/Fuller Road
  - Northbound US Route 1 approach – AM peak hour
  - Southbound US Route 1 approach – PM peak hour
  - Eastbound Joplin Road approach – AM peak hour
  - Westbound Fuller Road approach – PM peak hour
- Russell Road/I-95 (Northbound) On Ramp
  - Eastbound Russell Road approach – PM peak hour

- US Route 1/Corporate Drive/United Van Lines Driveway
  - Southbound US Route 1 approach – PM peak hour
- US Route 1/Telegraph Road
- Southbound US Route 1 approach – PM peak hour
  - Fuller Road/Fuller Heights Road
  - Southbound Fuller Heights Road approach – AM and PM peak hours
- Russell Road/US Route 1 Northbound ramps
  - Southbound ramp approach – AM peak hour



2011 Existing a.m. and p.m. Peak Hour Queues by Lane Group (VISSIM)

US Route 1 Corridor at Marine Corps Base Quantico
Planning/Preliminary Engineering Study
Federal Highway Administration
Eastern Federal Lands Highway Division

Kimley-Horn and Associates, Inc.

FIGURE 2-10

2.2 Environmental

2.2.1 Land Use

GIS data and published zoning maps from Prince William County, Stafford County, and MCB Quantico were used to determine land uses along the US Route 1 corridor and cross streets (**Figure 2-11** through **Figure 2-13**). Land use north of Joplin Road/Fuller Road is characterized by general business or low-density residential use. Between Joplin Road and Russell Road along the western edge of the roadway, land is designated as agricultural. However, these properties are being used for cultural and recreational purposes, including the Marine Corps Heritage Center and Locust Shade Park. MCB Quantico abuts the eastern edge of the roadway from Fuller Road to Telegraph Road, and crosses the study area at Russell Road. The MCB Quantico property that is within the study area is mostly undeveloped, residential, or commercial. MCB Quantico has also designated the areas surrounding Chopawamsic Creek as a Protected Natural Area (PNA).

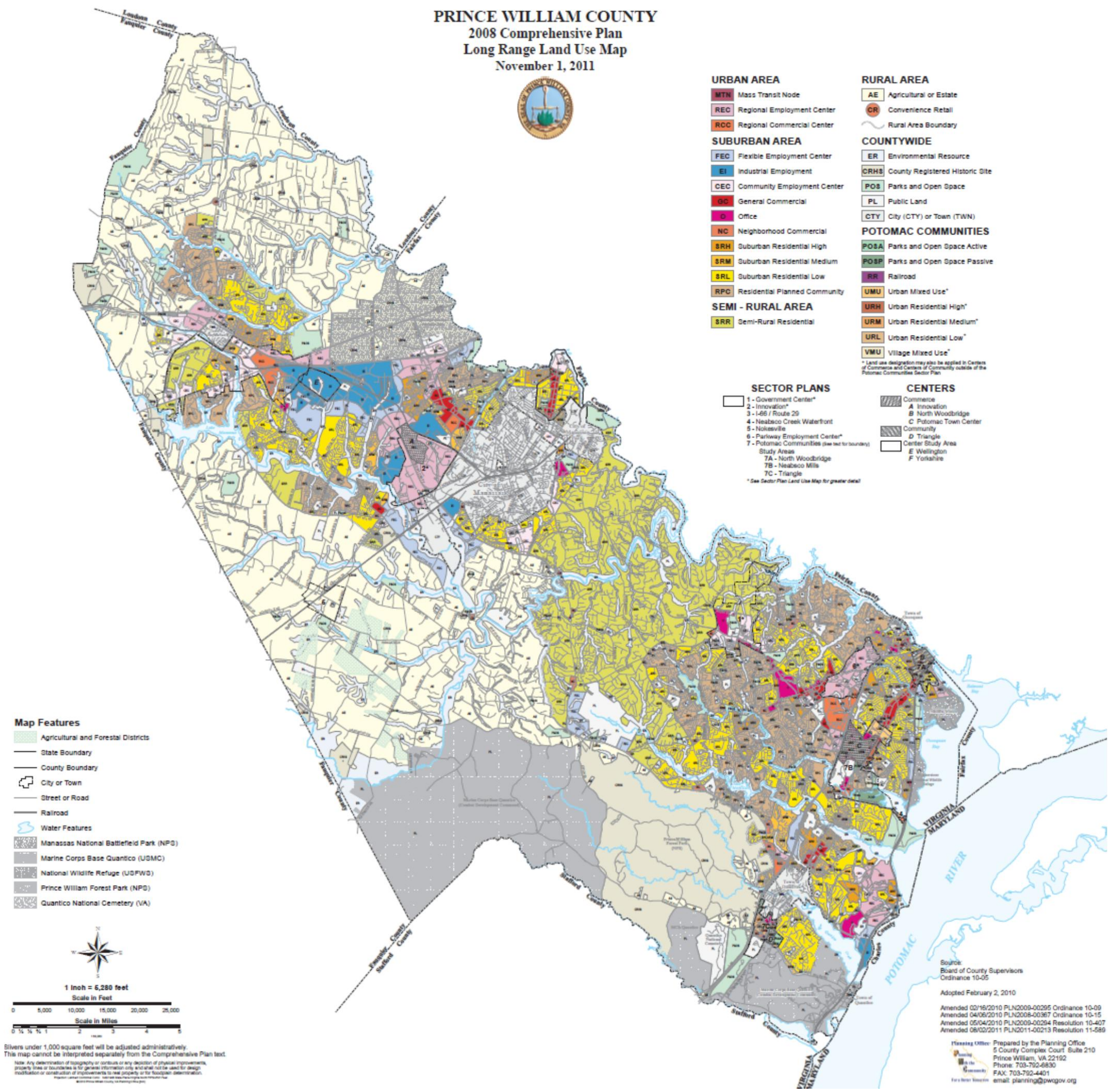
The Project area intersects with Boswell's Corner, a future economic development site, in the vicinity of Telegraph Road. Boswell's Corner is a historic and cultural hub of Stafford County that serves as the gateway to the county from the north. Currently, land use in the Boswell's Corner area consists of small retail stores, auto service facilities, and some residences. The Stafford County Master Redevelopment Plan proposes to develop Boswell's Corner to provide high-quality office and retail support for the anticipated growth of MCB Quantico and surrounding areas in Stafford and Prince William Counties. The Quantico Corporate Center on Corporate Drive, currently under construction, is the first phase of this plan. The ultimate goal for the redevelopment is for Boswell's Corner to represent Stafford County as "an area for economic progress and not solely a bedroom community" (Stafford County Master Redevelopment Plan, 2009). A map of the Boswell's Corner Preliminary Master Plan is included as **Figure 2-14**. The map also details some concerns and reservations, such as historically valuable properties, cemeteries, or natural resources that may pose challenges to redevelopment.

2.2.2 Farmland

Conversion of farmland to non-agricultural use is regulated by the US Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS) under the Farmland Protection Policy Act (FPPA). Under this Act, federal actions must consider the effect on prime farmland, unique farmland, and farmland of statewide and local importance. Prime farmland is defined as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses." Farmland of statewide importance is land that may not meet federal recommendations of prime farmland, but has the same productive value at the state level. Farmland is classified independently of land use, but cannot be open water or urban built-up land (National Soil Survey Handbook, NRCS, revised February 2012). Conversion of farmland requires the completion of a USDA Farmland Conversion Impact Rating Form (Form AD-1006) and an NRCS Form CPA-106.

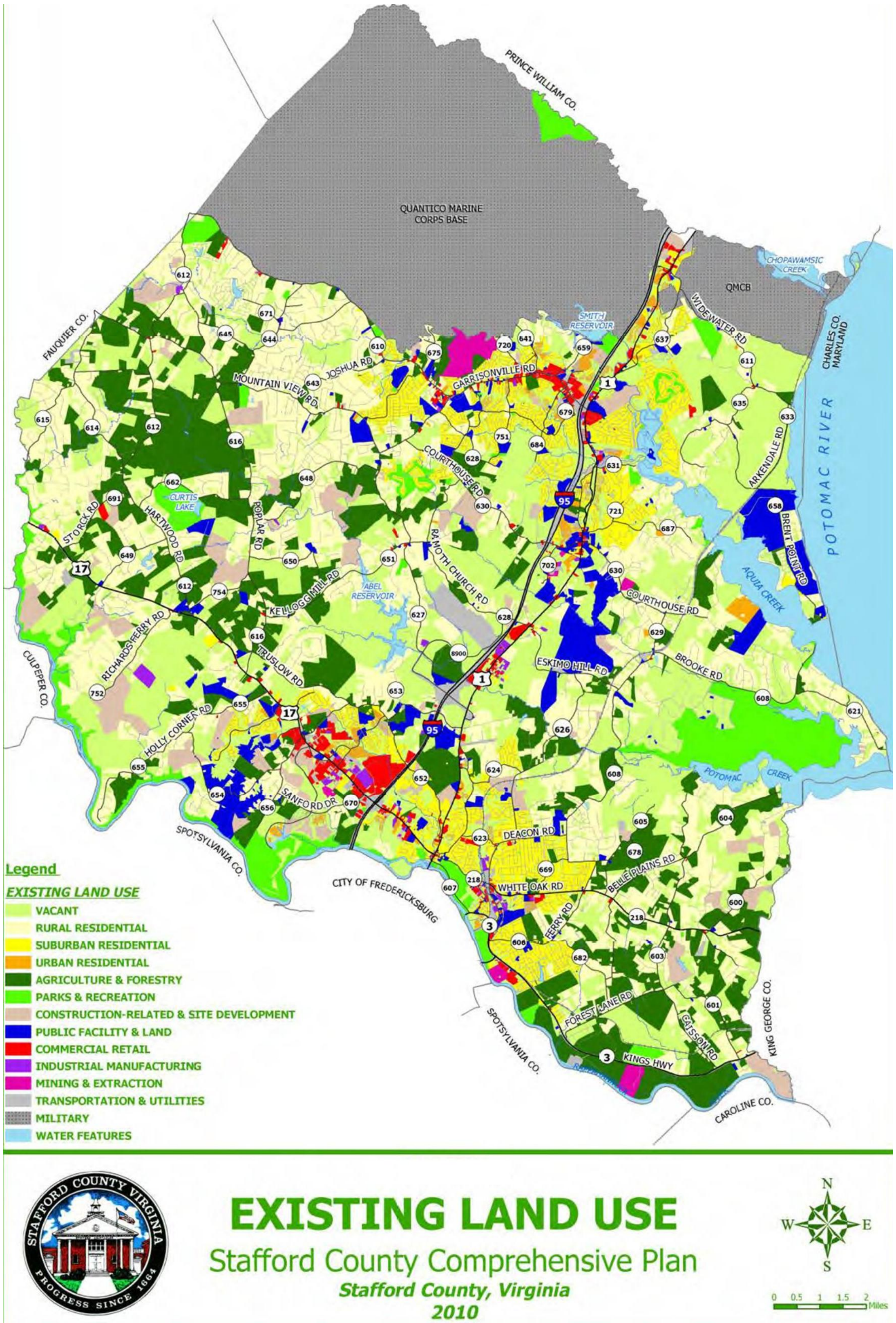
GIS data from NRCS shows areas designated as prime farmland and farmland of statewide importance throughout a large portion of the study area, particularly north of Russell Road (**Figure 2-15**). Some of these areas have been developed into commercial properties, residential neighborhoods, and existing roadways. No areas of unique or locally important farmland were identified. No agricultural land uses were observed within the study area during the initial field reconnaissance. One 12-acre undeveloped parcel containing prime farmland abuts the roadway south of Courage Lane; however, the Stafford County zoning map indicates that this parcel is zoned for business and industrial use. MCB Quantico land use maps indicate that no property of the Base has been designated as agricultural.

Figure 2-11: Prince William County Long Range Land Use Map



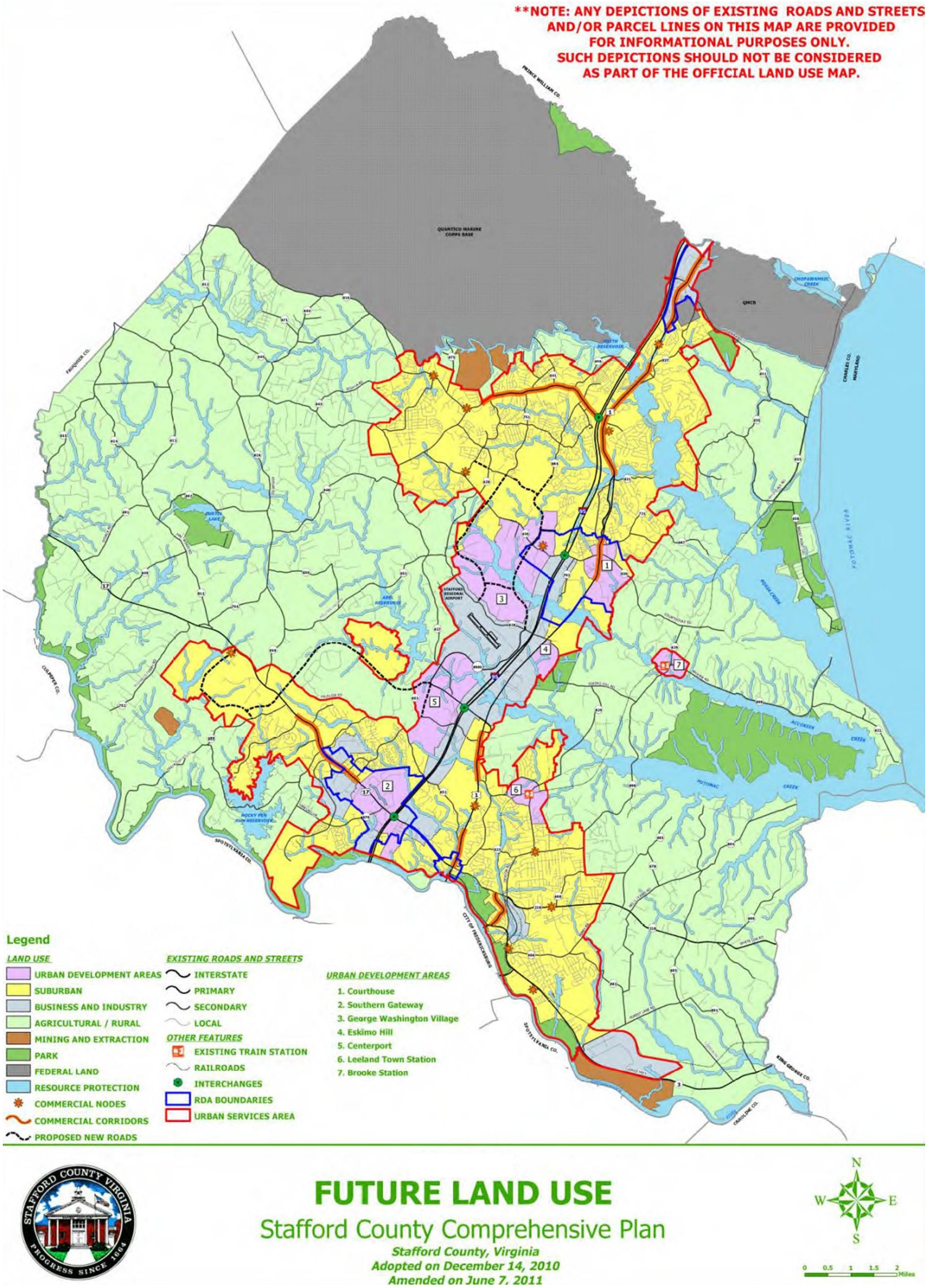
Source: Prince William County Comprehensive Plan, 2008 (Revised 2010), Prince William County, VA Planning Office

Figure 2-12: Stafford County Existing Land Use



Source: Stafford County Comprehensive Plan, 2010, Stafford County, VA Planning Commission.

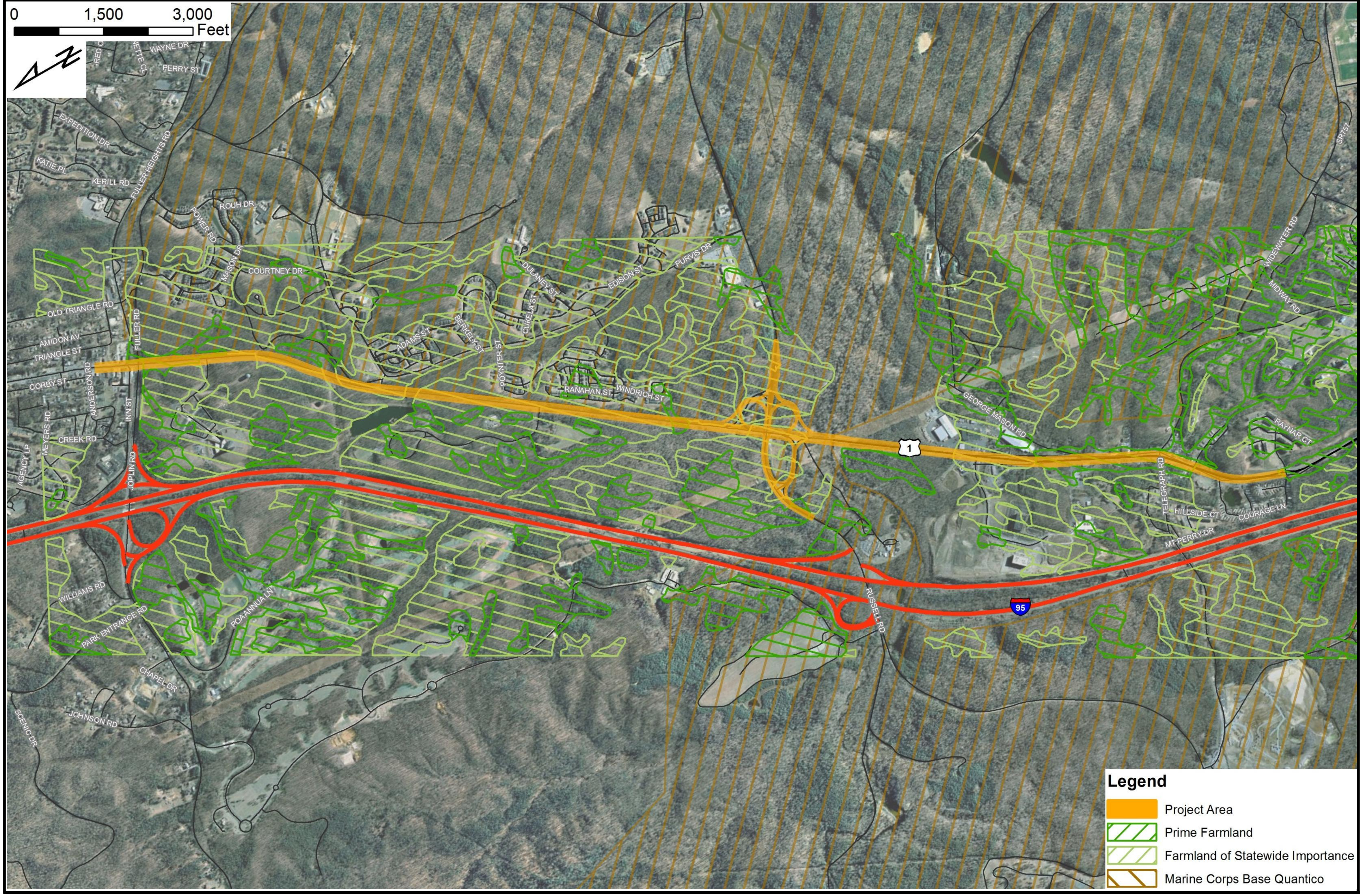
Figure 2-13: Stafford County Future Land Use



Source: Stafford County Comprehensive Plan, 2010, Stafford County, VA Planning Commission.

Figure 2-14: Boswell's Corner Master Redevelopment Plan

Source: Stafford County Master Redevelopment Plan: Boswell's Corner, 2009, Stafford County, VA.



Farmland

Route 1 Corridor Marine Corps Base Quantico
Planning/Preliminary Engineering Study
United States Federal Highway Administration (FHWA)

Kimley-Horn and Associates, Inc.

FIGURE
2-15

2.2.3 Water Resources

2.2.3.1 Wetlands

Using GIS data from the National Hydrography Dataset, two large streams and multiple large tributaries were identified within the study area, including Little Creek at Fuller Road and Chopawamsic Creek at Russell Road (**Figure 2-16**). The US Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI) data shows wetlands associated with Chopawamsic Creek.

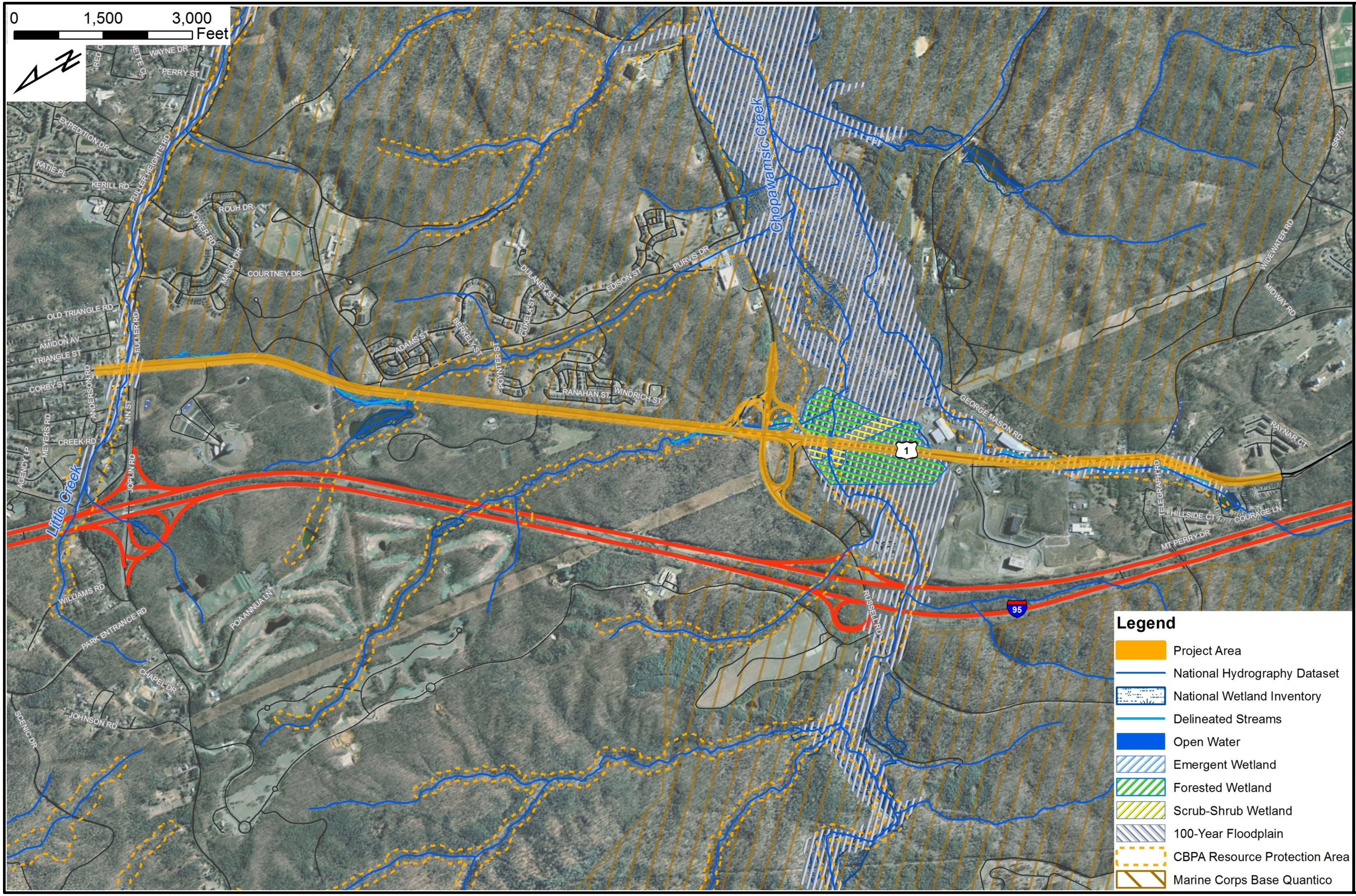
On September 10-12 and October 9, 2012, qualified wetland scientists of Kimley-Horn and Associates, Inc. conducted a preliminary routine delineation of wetlands and other Waters of the United States (WOUS) within the study area. The study area for the delineation effort included all areas within 100 feet of the proposed outer limits of disturbance for a six-lane configuration. This 100-foot buffer was used in order to account for potential alignment changes that may have occurred during preliminary engineering, including the possibility of an eight-lane configuration. The study area also included a 1,000-foot buffer around the southern quadrants of the intersection of US Route 1 and Joplin Road/Fuller Road, a 1,200-foot buffer around the intersection at Russell Road, and a diamond-shaped buffer at Telegraph Road to account for all potential intersection or interchange alternatives. The delineation was conducted in general accordance with procedures described in the U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual 1987* and *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2)*. Wetland boundaries and WOUS centerlines were flagged in the field and recorded using GPS. Wetland areas were categorized according to the Cowardin Wetland Classification System. Roadside ditches within the study area were not mapped as jurisdictional features due to their small size and lack of connectivity to natural surface waters. However, in the event that USACE chooses to exert jurisdiction, these features would be mapped as WOUS, and impacts would be calculated accordingly.

The delineation identified several types of wetlands within the study area, including palustrine forested (PFO), palustrine scrub-shrub (PSS), and palustrine emergent (PEM) wetlands, as well as open water (POW; **Table 2-7**).

Table 2-7: Acres/Linear Feet of Wetlands and WOUS Within Study Area by Type

Type	Identified Within Study Area
Palustrine Forested (PFO)	27 ac
Palustrine Scrub-Shrub (PSS)	4.8 ac
Palustrine Emergent (PEM)	1.6 ac
Open Water (POW)	0.5 ac
Total Wetlands	**33.9 ac**
Streams	5335 LF

The majority of these wetlands were headwater or floodplain wetlands associated with stream systems. The stream systems consist of unnamed tributaries to either Little Creek or Chopawamsic Creek. These delineated streams and wetlands can be viewed in **Figure 2-16**.



Water Resources

Route 1 Corridor Marine Corps Base Quantico
Planning/Preliminary Engineering Study
United States Federal Highway Administration (FHWA)

Kimley-Horn and Associates, Inc.

FIGURE
2-16

2.2.3.2 Floodplains

Executive Order No. 11988, issued May 24, 1977, directs Federal agencies to avoid to the extent possible adverse impacts associated with the occupancy, modification, and development of floodplains. The 100-year floodplain is defined by the Federal Emergency Management Agency (FEMA) as "the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year."

GIS data from Prince William and Stafford Counties was used to identify the 100-year floodplain. The intersection of US Route 1 and Fuller Road is within the 100-year floodplain associated with Little Creek. The Chopawamsic Creek floodplain intersects the study area south of Russell Road. A floodplain associated with an unnamed tributary to the Chopawamsic Creek runs northward along the western edge of US Route 1. These floodplains can be viewed in **Figure 2-16**.

2.2.3.3 Chesapeake Bay Preservation Act

Both Prince William and Stafford Counties are located within Tidewater Virginia as described in the Chesapeake Bay Preservation Act of 1988 (CBPA). Therefore, they are required to designate Resource Protection Areas (RPAs) to protect water quality in the Bay Area. RPAs include all tidal wetlands, water bodies with perennial flow, all wetland areas contiguous with a water body with perennial flow, and a buffer area that includes any land within 100 feet of an above-mentioned feature. Prince William County also designates any areas within the 100-year floodplain to be within an RPA. The remaining land within both counties has been designated a Resource Management Area (RMA), which requires responsible land management and development practices to generally preserve water quality in the Chesapeake Bay region. Public roadway projects are exempt from CBPA regulations regarding buffer encroachment. However, supporting facilities such as stormwater management ponds are not exempt and would be subject to CBPA regulations. Regardless of exemption, localities may require a site-specific RPA determination in the event of any impacts to RPAs. Therefore, impacts to RPAs should be minimized to the maximum extent practicable in order to comply with CBPA water quality regulations.

Prince William and Stafford County GIS data was used to identify the county-designated locations of RPAs within the study area. Four RPAs intersect the study area; one is associated with Little Creek along Fuller Road, and the remaining three are associated with Chopawamsic Creek and its tributaries. These RPAs can be viewed in **Figure 2-16**.

2.2.4 Wildlife and Habitat

The Endangered Species Act (ESA) requires that each Federal agency ensure that any action they authorize, fund, or enact is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Impacts to state-listed endangered and threatened species are regulated by the Virginia Department of Game and Inland Fisheries (DGIF) and the Virginia Department of Conservation and Recreation (DCR), whereas impacts to federally-listed species are regulated by the US Fish and Wildlife Service (USFWS) with support from DCR. The DGIF-standard study area for endangered species includes all lands and water bodies within a two-mile radius of the Project area.

In 1993, following the DCR recommendation that the Chopawamsic Creek Marsh be designated for special protection and management consideration, MCB Quantico conferred Protected Natural Area (PNA) designation upon the lower Chopawamsic Creek Basin.

The Chopawamsic Creek Basin was determined to be important to the Base's bald eagle populations as well as many other wetland-dependent fish and wildlife species (INRMP, MCB Quantico, 2007). The PNA is accessible to the public via the Virginia Birding and Wildlife Trail (discussed in Parks and Recreation). The Project area intersects the northwestern portion of the PNA south of Russell Road. The boundaries of the PNA can be viewed in **Figure 2-17**.

According to the DGIF Virginia Fish and Wildlife Information Service Initial Project Assessment, performed on November 27, 2012 (see Appendix G), there are two federally-listed endangered animal species and six state-listed threatened or endangered animal species with the potential to occur within the study area. The dwarf wedgemussel (*Alasmidonta heterodon*) and the Atlantic sturgeon (*Acipenser oxyrinchus*) are both federally-listed endangered species, although no confirmed sightings have been reported in the study area. No streams or rivers within the study area are listed as potential habitat for either species. Based on habitats observed within the study area during the field reconnaissance, unconfirmed state threatened and endangered species with potential habitats include the peregrine falcon (*Falco peregrinus*) and loggerhead shrike (*Lanius ludovicianus*). Both of these species can thrive in a wide variety of habitats, several of which are present within the study area.

DGIF reports confirmed sightings of the bald eagle (*Haliaeetus leucocephalus*) within a two-mile radius of the Project area; however, the Center for Conservation Biology VaEagles Nest Locator site (http://www.ccb-wm.org/virginiaeagles/eagleData.php?AgreeDataUse=on&SubmitAgreeTerms=View+Data, accessed November 19, 2012; Appendix) shows that there are no bald eagle nests within 660 feet of the Project area. The project area also does not intersect with a bald eagle concentration area according to the USFWS Project Review application (http://www.fws.gov/northeast/virginiafield/endspecies/Project_Reviews_Introduction.html, accessed November 30, 2012).

The USFWS Project Review application was also used to determine the presence of federally-listed endangered or threatened plant and animal species. The review identified potential habitat for the federally-endangered harperella (*Ptilimnium nodosum*) and the federally-threatened, state-endangered small whorled pogonia (*Isotria medeoloides*) (see the Species Conclusion Table in the Appendix). Several areas within the Project area fit the description for "suitable habitat" for both species.

2.2.5 Historic Resources

Federal agencies are required by the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and other provisions of Federal law to consider effects on historic resources that are eligible for the National Register of Historic Places (NRHP) in the planning and execution of their projects. Section 106 of the National Historic Preservation Act and its implementing regulations at 36 CFR Part 800 requires Federal agencies to clearly define the scope of their undertaking; develop an Area of Potential Effects (APE); make a reasonable and good-faith effort to identify and evaluate historic properties; and assess the project's effects when historic properties are present. Consultation takes place with the State Historic Preservation Office (SHPO), which in Virginia is the Department of Historic Resources (DHR); the Advisory Council on Historic Preservation (ACHP); Indian tribes that attach religious or cultural significance to historic properties that may be affected by an undertaking; local governments; interested public; and other stakeholders. Resources protected under Section 106 include all architectural or archaeological sites that are listed on or eligible for listing on the NRHP. Only properties that meet one of the following NRHP eligibility criteria are deemed eligible:

Criterion A. The property is associated with events that have made a significant contribution to the broad patterns of American history;

Criterion B. The property is associated with the lives of persons significant in our past;

Criterion C. The property embodies the distinctive characteristic of a type, period, or method of construction or that represent the work of a master, or possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

Criterion D. The property has yielded, or may be likely to yield, information important in prehistory or history (Cultural Resources Architectural Survey, Coastal Carolina Research 2012, included in the Appendix).

Federal agencies are tasked with producing an APE, which includes all areas of direct physical effects as well as visual and auditory effects that could have adverse impacts on historic character. The APE is subject to approval by SHPO.

In October 2012, Coastal Carolina Research (CCR) conducted literature reviews and field surveys of historic architectural and archaeological features within the Project area and made recommendations regarding their eligibility for listing on the NRHP. The full reports for architectural and archaeological resources are included in the Appendix. The Stafford County Master Redevelopment Plan of Boswell's Corner also makes provisions for properties that may not be eligible for the NRHP but are still historically and culturally valuable to the community.

The APE for direct effects to historic resources was defined as 100 feet on each side of the existing US Route 1 roadway and portions of intersection roadways at the proposed intersection/interchange improvement areas. In addition, circular areas with a 1,000-foot radius are included at the intersections of Joplin Road, Russell Road, and Telegraph Road to account for all potential intersection or interchange alternatives. For indirect effects involving historic architecture, the APE includes those areas within 500 feet of the existing roadways in the study area and those resources visible from the roadways and proposed intersection areas. The APE was not developed in consultation with DHR and is subject to approval. Any encroachment of the Project outside of the APE may require additional studies and consultation with DHR.

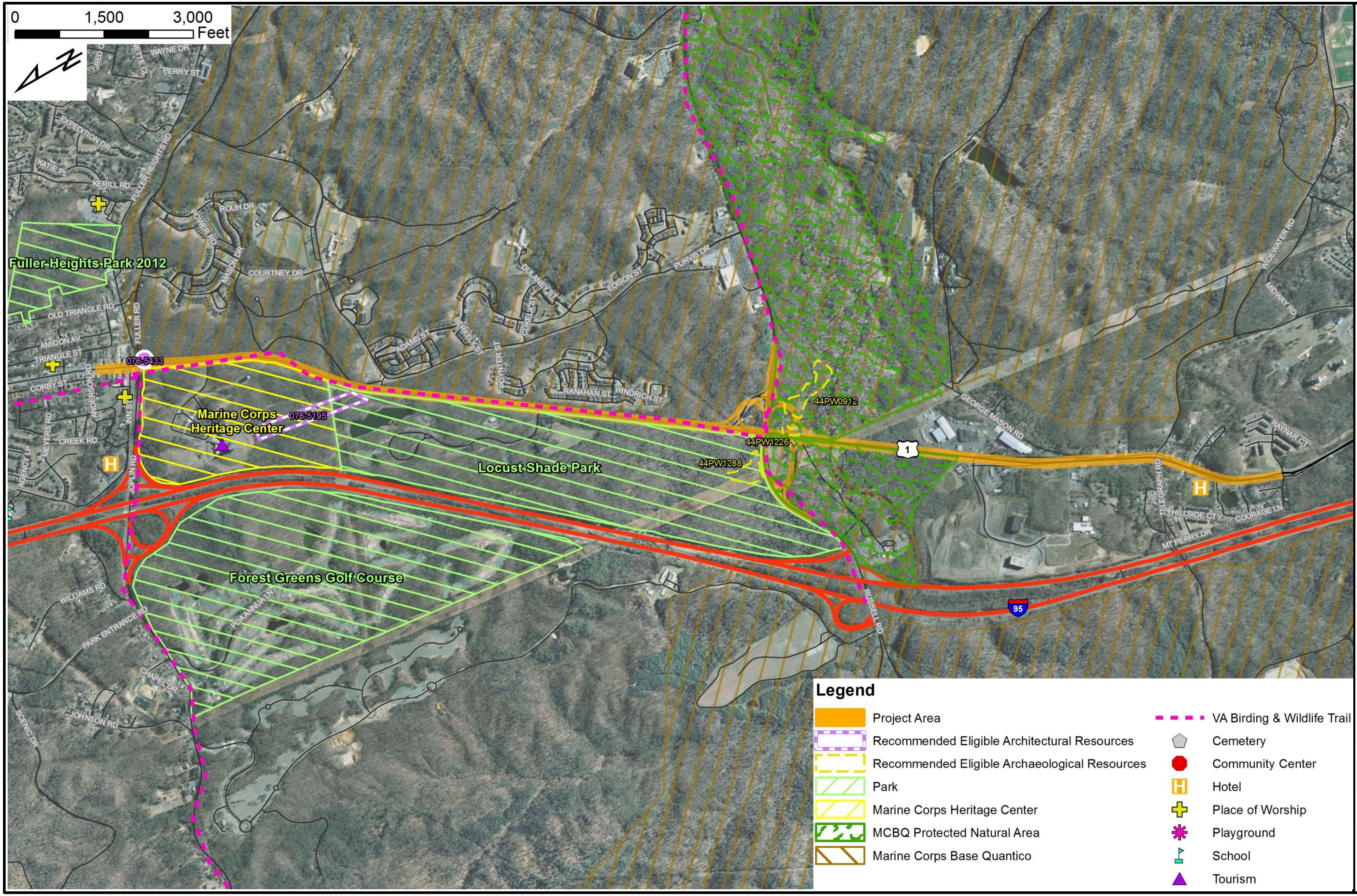
No previously-determined eligible architectural resources were identified within the APE. The architectural report identifies two previously unevaluated historic resources that are recommended eligible for the NRHP: the section of Kings Highway (VDHR# 076-5195) located approximately 400 feet from the Project area; and the Iwo Jima Memorial statue (VDHR # 076-5433) adjacent to US Route 1 in the southeast quadrant of the intersection with Fuller Road. One previously recorded archaeological site, the Lithic Workshop (VDHR# 44PW1226) located along US Route 1 south of Russell Road, has already been determined to be eligible for the NRHP. Two other archaeological sites have been recommended eligible: the Waugh's Purchase Cobble Quarry site (VDHR# 44PW1288) adjacent to Russell Road to the north and an unnamed site (VDHR# 44PW0912) in the southeast quadrant of Russell Road and US Route 1 (**Figure 2-17**). No newly-recorded archaeological sites were recommended eligible for the NRHP.

2.2.6 Parks and Recreation

The Marine Corps Heritage Center, associated with the National Museum of the Marine Corps, is located south of Joplin Road and west of US Route 1.

The Center includes the Museum, the Semper Fidelis Memorial Park and Chapel, a trail network that will eventually connect to Locust Shade Park to the south, and a playground. Locust Shade Park, owned by Prince William County, is south of Joplin Road, adjacent to US Route 1 to the west.

The park includes fishing and boating facilities, a driving range and miniature golf course, a batting cage, an amphitheater, and various other recreational activities. The Prince William Loop of the Virginia State Birding and Wildlife Coastal Trail, a driving trail that showcases the area's mixed woodlands and the extensive wetlands along Chopawamsic Creek, includes US Route 1 from Russell Road to the northernmost point of the study area. The trail is not a discrete path, but rather a mapped route along existing roads that highlights natural features. An access road to the Chopawamsic Creek Watchable Wildlife Area is included in the loop and is accessible from US Route 1 just south of Russell Road. The trail and wildlife viewing area includes a platform to observe wildlife such as waterfowl, migratory songbirds, ospreys, bald eagles, and herons. These resources can be viewed in **Figure 2-17**.



Parks, Recreation, Section 4(f), and Community Facilities

Route 1 Corridor Marine Corps Base Quantico
Planning/Preliminary Engineering Study
United States Federal Highway Administration (FHWA)

Kimley-Horn and Associates, Inc.

FIGURE 2-17

2.2.7 Section 4(f) and 6(f)

The Department of Transportation Act (DOT Act) of 1966 includes a special provision (Section 4(f)) that stipulates that the Federal Highway Administration (FHWA) and other DOT agencies cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or eligible or listed historical sites unless the following conditions apply:

- There is no feasible and prudent alternative to the use of land.
- The action includes all possible planning to minimize harm to the property resulting from use.

A "use" of a Section 4(f) property includes temporary, constructive, and permanent impacts. Architectural resources are protected by Section 4(f) if they are listed on or eligible for listing on the NRHP. Archaeological resources are protected if they are eligible and are recommended for preservation in place. All recommendations and determinations are subject to concurrence by SHPO.

Resources within the Project area that qualify or potentially qualify for protection under Section 4(f) include the following:

- Iwo Jima Memorial statue (VDHR# 076-5433)
- Lithic Workshop (VDHR# 44PW1266)
- Waugh's Purchase Cobble Quarry (VDHR# 44PW1288)
- Unnamed archaeological site (VDHR# 44PW0912)
- North Kings Highway Road Section (VDHR# 076-5195)
- Marine Corps Heritage Center
- MCB Quantico Protected Natural Area
- Virginia Birding and Wildlife Trail - Prince William Loop
- Locust Shade Park

The Land and Water Conservation Fund Act (LWCFA) of 1965 (16 USC 4601-4 et seq.) established a funding source to assist state and federal agencies in the acquisition and development of public outdoor recreational areas and facilities. Section 6(f) of the LWCFA requires that all properties "acquired or developed, either partially or wholly, with LWCF funds" must be maintained as such in perpetuity. No Section 6(f) resources were identified within the Project area (National Park Service, http://waso-lwcf.ncrc.nps.gov/public/index.cfm, accessed March 21, 2013).

2.2.8 Community Facilities and Services

Federal agencies are required by NEPA to consider the social and economic impacts of proposed projects, including impacts to functionality, connectivity, and access of community facilities and public services.

Aside from the Section 4(f) sites discussed above, no other community facilities, including police stations, fire and rescue stations, hospitals, commuter lots, libraries, or public schools were identified within the Project area.

2.2.9 Air Quality

The Clean Air Act, which was last amended in 1990, requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly.

Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings. EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants, including: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), Particulate Matter ($PM_{2.5}$ and PM_{10}), and sulfur dioxide (SO_2).

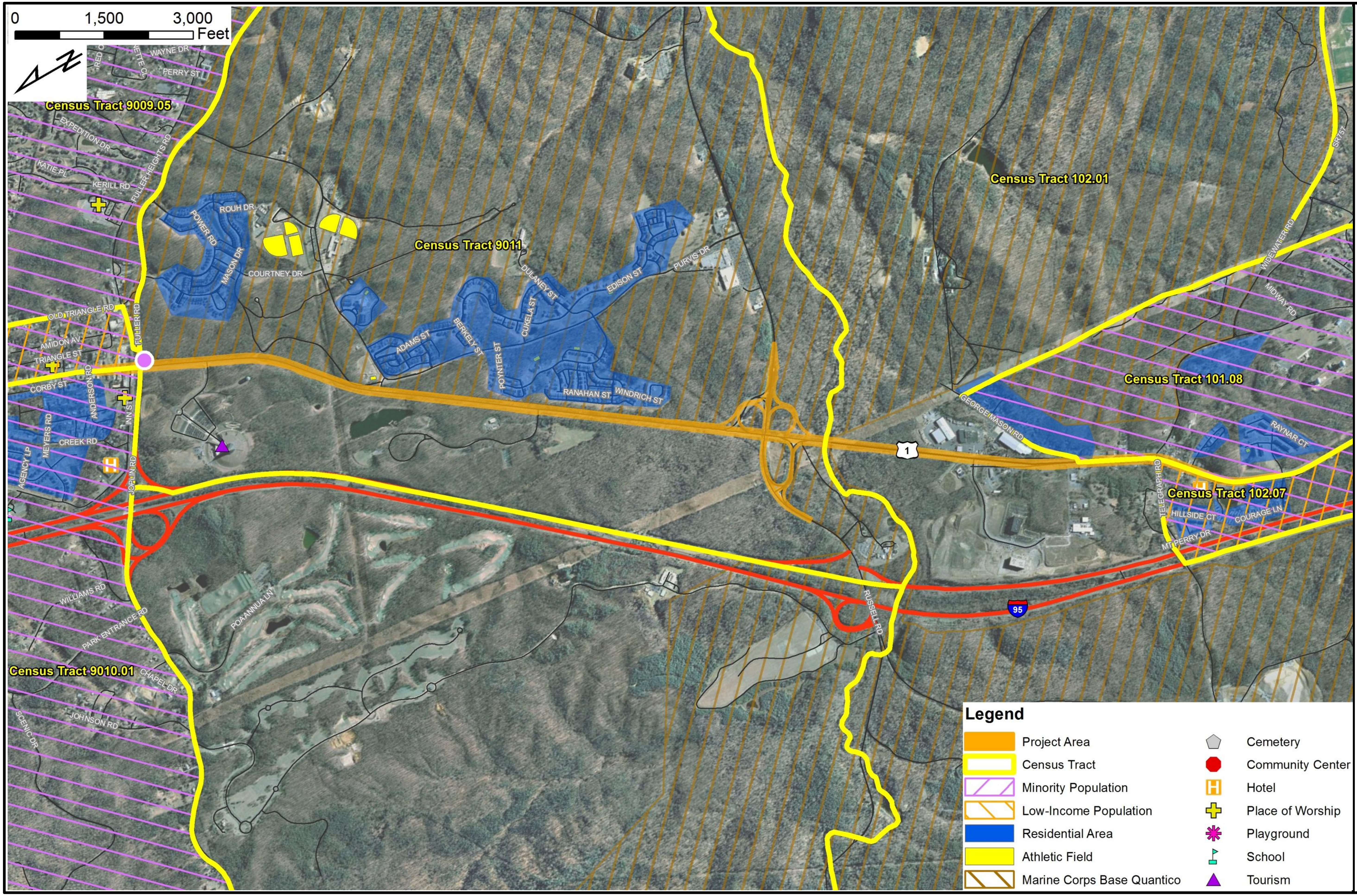
According to the Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) and the EPA Green Book Nonattainment Areas for Criteria Pollutants, Prince William County is within a marginal Eight-Hour Ozone Nonattainment Area, and Stafford County is within an Eight-Hour Ozone Maintenance Area.

The Project is determined to be regionally significant in the VDOT Six-Year Improvement Plan (SYIP; UPC #100456). Therefore, it has already been evaluated for regional air quality conformity.

2.2.10 Noise

A traffic noise impact occurs when the existing or future noise levels approach or exceed the noise abatement criteria (NAC) or when predicted future traffic noise levels exceed the existing noise level by 10 or more decibels (FHWA; VDOT). The Project would be considered a Type I Project per FHWA noise regulations and would therefore require a noise analysis. A study area of 500 feet from the Project limits was used to identify the following features, listed as potentially sensitive noise receptors under the FHWA Noise Abatement Criteria (NAC), which would potentially be impacted by increased traffic and/or construction noise (**Figure 2-18**):

- Locust Shade Park
- The National Museum of the Marine Corps and Heritage Center campus (http://www.marineheritage.org/HeritageCenter_Today.asp)
- First Assembly of God Church, located north of Joplin Road
- Spring Lake Hotel, located along US Route 1 to the west, south of Telegraph Road
- Eight residential areas
    - Anderson Road neighborhood
    - Mason Drive neighborhood on MCB Quantico
    - Purvis Road/Poyner Street neighborhood on MCB Quantico
    - Telegraph Road community, including Minor Drive and Mt. Perry Drive
    - George Mason Road community
    - Clearview Lane community
    - Merryview Drive community
    - Crystal Lake Mobile Home Park on Courage Lane
    - Various individual residences throughout the corridor



Noise and Environmental Justice

Route 1 Corridor Marine Corps Base Quantico
Planning/Preliminary Engineering Study
United States Federal Highway Administration (FHWA)

Kimley-Horn and Associates, Inc.

FIGURE
2-18

2.2.11 Environmental Justice

Executive Order No. 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," directs federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of projects on the health or environment of minority and low-income populations to the greatest extent practical and permitted by law. Minority populations are identified as census tracts with percentages of minority persons that are greater than the percentages of minority persons in the county. Low-income populations are defined as census tracts with a percentage of individual persons with incomes below poverty level that is greater than that of the county as a whole.

Data from the 2010 Census and 2010 American Community Survey Five-Year Estimates was reviewed at the Census Tract level for the year 2010 population, racial/ethnic, and poverty data to determine the presence of environmental justice populations within the study area. Prince William County has a minority percentage of 51.3 percent; Stafford County has a minority percentage of 32.2 percent (**Table 2-8**). Any census tracts with a minority percentage higher than 51.3 percent in Prince William County or 32.2 percent in Stafford County within the study area is considered a minority population (highlighted in red in **Table 2-8**). Prince William County has a low-income percentage of 5.3 percent; Stafford County has a low-income percentage of 4 percent (**Table 2-8**). Any census tracts with a low-income percentage higher than 5.3 percent in Prince William County or 4 percent in Stafford County within the study area is considered a minority population (highlighted in red in **Table 2-8**). A map of the census tracts within the study area can be viewed in the Appendix G.

Table 2-8: Percentage of Minorities and Individuals Below Poverty within the US Route 1 Quantico Study Area in 2010

County	Census Tract	% Minority	% Below Poverty
Prince William County	**Countywide**	**51.3**	**5.3**
	9009.01	**77.5**	**15.4**
	9009.05	**62.2**	5.1
	9010.01	**56.7**	0.8
	9011	34.8	3.8
Stafford County	**Countywide**	**32.2**	**4.0**
	101.08	**38.8**	2.6
	102.01	18.2	0.0
	102.07	**53.2**	**7.7**

Five census tracts intersecting the project area contain environmental justice populations. Due to the minimal improvements proposed north of Joplin Road and Fuller Road, no impacts to Census Tracts 9009.01, 9009.05, and 9010.01 are anticipated. Census Tracts 101.08 and 102.07 contain minority and/or low-income populations that would potentially be impacted by the Project (**Figure 2-18**).

2.2.12 Hazardous Materials

The likelihood of encountering contaminated soil or groundwater in the Project area and its effect on right-of-way acquisition for the project must be reviewed as part of any environmental analysis. A Radius Map Report from Environmental Data Resources, Inc. (EDR), generated on September 15, 2011, showed search results from federal, state, and local hazardous materials databases, using American Society for Testing and Materials (ASTM) standard search distances (Appendix G). The databases revealed the following Recognized Environmental Conditions (RECs): one CERC-NFRAP site north of Fuller Road, three RCRA Small Quantity Generator sites, three RCRA Conditionally Exempt Small Quantity Generator sites, three RCRA NonGen sites, 20 Leaking Underground Storage Tanks (LUSTs), 26 Leaking Tanks (LTANKS), 24 registered Underground Storage Tanks (USTs), and 22 SPILLS sites.

2.3 Existing Conditions Conclusions

Analysis of the existing conditions showed that most study intersections in the study area operate at acceptable levels of service and delays. The two intersections that at least one of the analysis software recognized as having unacceptable overall delays and levels of service were:

- US Route 1/Joplin Road/Fuller Road
- Fuller Road/Fuller Heights Road

Each of these intersections is located in close proximity to access control points to MCB Quantico on Fuller Road (Main Gate) and Russell Road (Back Gate). Heavy inbound traffic during the AM peak hour and outbound traffic during the PM peak hour drive these operational deficiencies. Preliminary HCM analysis results of the Fuller Road/Fuller Heights Road indicated that it operates at LOS A in both peak hours. However, due to its close proximity to the Fuller Road intersection with US Route 1, the queues from the westbound approach to US Route 1 routinely extend back past the Fuller Heights intersection and prevent vehicles from turning in and out of this location. This is reflected in the VISSIM microsimulation results and confirmed through field observations.

The following unsignalized intersections have side street approaches that operate at LOS E or worse according to at least one of the analysis software:

- Fuller Road/Fuller Heights Road
- Russell Road/US Route 1 (Northbound) Ramps
- US Route 1/George Mason Drive (North)

Traffic flow on US Route 1 is highly directional with heavy northbound volumes during the AM peak period and heavy southbound volumes during the PM peak period. Long queues for turning movements that exceed storage capacity observed during peak hour field observations and reflected by the 95^{th} percentile volumes (according to Synchro analysis) occurred at the following intersections:

- US Route 1/Joplin Road/Fuller Road – northbound left (AM and PM peak hour)
- Russell Road/I-95 (Northbound) On Ramp – eastbound left (PM peak hour)

Recently completed roadway improvements to the US Route 1/Joplin Road/Fuller Road intersection and future planned improvements to the MCB Quantico Main Gate should help alleviate some congestion. There is also an approved design to reconstruct the Fuller Road/Fuller Heights Road intersection. An ongoing study is recommending improvements to the study intersections along Russell Road.

These existing capacity constraints documented here will hinder future planned growth along the corridor at MCB Quantico Westside, Quantico Corporate Center, and Boswell's Corner, which will each bring increased activity and traffic volumes to US Route 1. This growth will likely increase the delay on side street approaches and congestion on US Route 1. In addition to these existing and future intersection capacity constraints, the following safety and access management issues must be addressed in the recommended design for the corridor:

- Lack of a protected left-turn phase at US Route 1/Telegraph Road
- Lack of left turn lanes at the entrance to Locust Shade Park and George Mason Drive (north and south)
- Lack of paved shoulders and a dedicated bicycle facility between Russell Road and the Museum of the Marine Corps
- Lack of median to separate opposing traffic and manage turning movements throughout the US Route 1 corridor
- Inadequate length of acceleration lane of Russell Road off-ramp to US Route 1 southbound
- Uncontrolled access to parking lots and driveways between George Mason Drive (north) and Telegraph Road